the OIL AND GAS JOURNAL

JULY 16, 1956

L.P.G. STORAGE UP 250%

in two years and still climing!

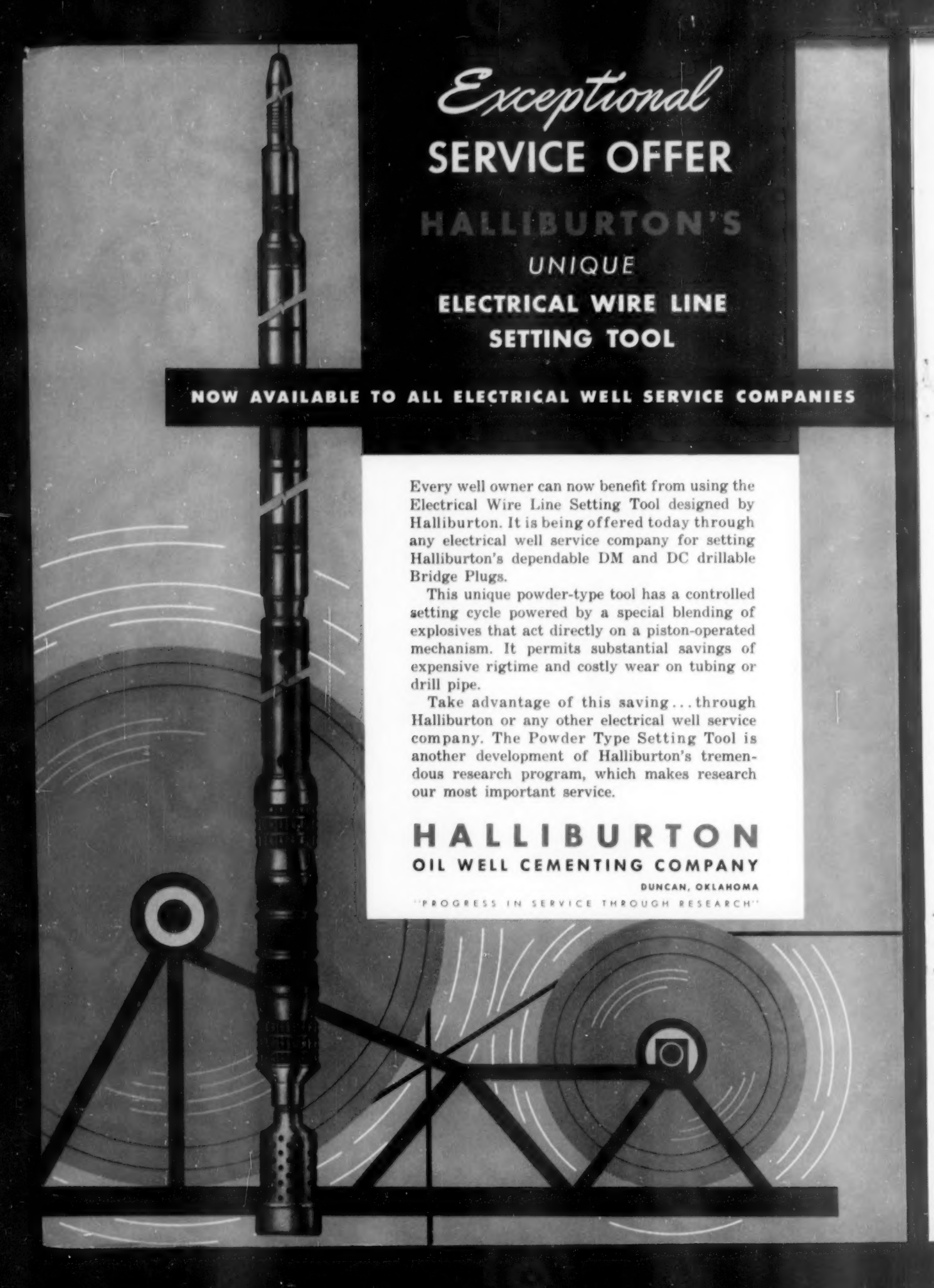
P. 58

Venezuela Takes Bids on Six More Lake Tracts p. 62

"Satellite" Compressor Station Successful p. 66

New Recovery Idea: "Condensing Gas" Drive p. 70

Better Piping and Vessels by Cold Extrusions • p. 84



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A Glance Ahead . . . . at press time

These trends will make TOMORROW'S NEWS

A full-scale test run is being readied for Esso's fluid coker at Baltimore. With the shakedown period believed over, the run should show interesting new data on yield, quality of products, and operating costs.

An entirely new type of liquid meter is being put in use on a products pipeline in West Texas.

The meter does not operate on the positive-displacement principle but uses a turbine in the flowing stream. A magnet on the turbine blade triggers an electronic circuit to record flow on a digital counter. The meter has been used for some time in the aircraft industry; it is just now breaking into petroleum fields. Its features of high throughput with small sizes, low maintenance, and high accuracy give it promise.

Taxes for the new highway program will have to be increased, almost before building starts on a big scale.

A lot of questions were left open in the bill passed by Congress last month. For one thing, the cost schedule didn't take into account the several billions that will be added by the Davis-Bacon wage amendment that was written in. And the higher prices for steel that threaten will further hike costs.

The next increase won't be saddled on the gasoline buyer. It will be put on industry by higher truck and other levies.

The recent sale of Premier Oil Refining Co. at a loss by three co-op owners may have a bearing on future operations of other co-op refineries.

The sale emphasized some basic changes in supply and transportation. Premier's owners found they could obtain products for their market facilities at a lower delivered cost from midwestern pipelines and Mississippi River points than from the Premier refineries in Texas.

This meant they had to dispose of their refinery output locally, and, since the bulk was not going to co-op members, they lost their tax advantage.

Gulf Coast refiners expect most of their premium gasoline demand to hit 100-octane in the near future.

Most sales are to big buyers who move the fuel southeast or to the East Coast by tanker. These refiners expect to meet this demand and, at the same time, retain their markets for aviation gasoline, with its still higher octane ratings. The result: Plans for additional 100-octane processing facilities will be announced shortly.

El Paso Natural's streamlined new refinery near Gallup will have an initial capacity of 6,500 bbl., with provision for a quick increase as needed. U.O.P. has the contract for process engineering.

By startup date late in 1957 there should be plenty of crude available. There was only 1,000 bbl. daily in the Four Corners area in April, but output is climbing in the booming Black Rock-Bisti area. This strat-trap field, 90 miles north of the refinery site, may provide all the refinery's initial needs.

Increased exports of gas to Canada by Panhandle Eastern, approved by the FPC, will have an effect on Trans-Canada pipeline. Union Gas in Ontario is getting Panhandle gas for 35 cents an M.c.f. It has an option to cancel the contract, on a year's notice, when Trans-Canada gas becomes available. But to win the market, the Canadian line may have to meet that price, which is well below the expected rate for Alberta gas in Toronto.

The OIL AND GAS JOURNAL

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TECHNOLOGY—OPERATION

Refining-Processing

Better Piping and Vessels by Cold Extrusion 84

By Gifford L. Hitz

New cold-extrusion techniques are being used to produce better prefabricated piping assemblies for refineries and chemical plants. Important savings in welding costs and inspection time are inherent advantages of the new process.

Tidewater's "Ideal" Preventive-Maintenance Program 96

By C. C. Carmine

Maintenance personnel at Tidewater's Avon, Calif., refinery have formulated the "ideal" preventive-maintenance program, and are administering portions of this program successfully. Scope of the program includes eight important factors.

Field Processing 117

The Foreman's Page 119

The Refiner's Notebook 121

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Drilling-Production

Radiation Logging—What It Is And What It Can Do For You 88

By E. R. Atkins, Jr.

Radiation logging can: (1) locate porous zones which might contain petroleum; (2) aid correlation between similar wells; (3) determine gas-oil interfaces; (4) evaluate porosity; (5) determine casing location; (6) log cased wells; and (7) evaluate beds drilled with oil-base mud.

Electricity Drives Offshore Rigs 94

By R. B. Fairman

The diesel-electric power system features variable voltage at constant engine speed. Electric-motor drives operated from this system provide smooth, instant power.

Producing Dually Completed Wells—2 100

By J. Zaba, Henry Schaefer, and George E. O'Neal

Casing size, depth, type of drive, productivity of both zones, and characteristics of the produced fluids should be considered when a dual-zone well is lifted.

You Can Reduce Lost-Circulation Problems 112

By E. H. Clark, Jr.

Circulation may be lost during casing operations as well as during drilling. Here is how it may happen, what the dangers are, and how to prevent it.

Pipelining

Lubricating Oil Reveals Wear in Pipeline Compressors 108

By J. L. Wilson and S. R. Sawyer

The use of spectrographic analysis of compressor lubricating oil promises to be an important maintenance tool for gas-pipeline operators.

Pipeline Patrol: Southern Pacific's Pushbutton Operation 125

By Larry Resen

Southern Pacific Pipelines' El Paso products pumping station is completely electrified and set up for pushbutton control. Two 300-hp. pumps move 14,000 bbl. per day into the 8-in. main line at 1,400 psi.

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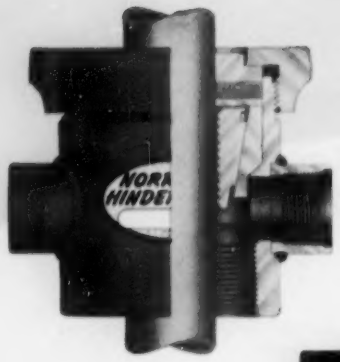

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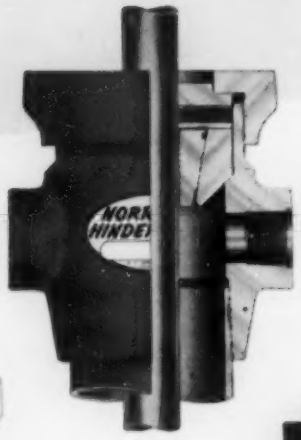

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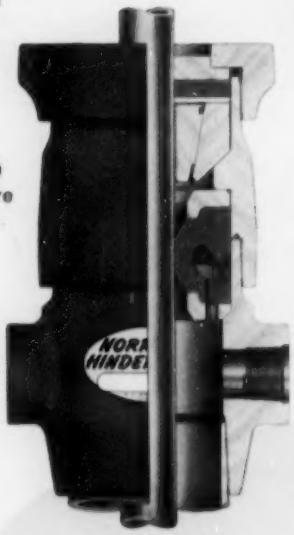

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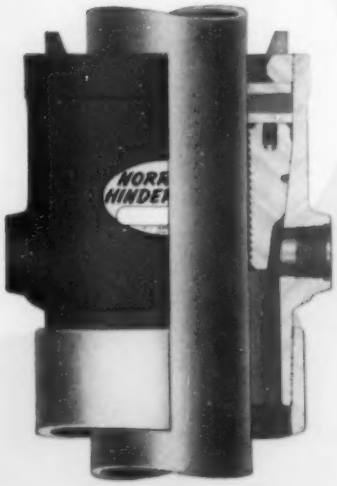

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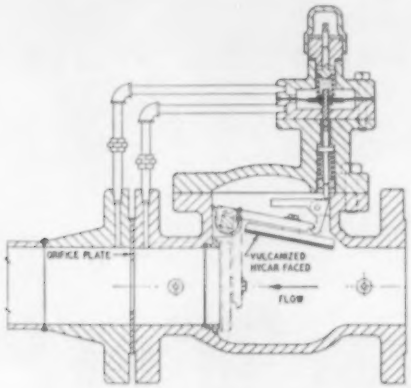
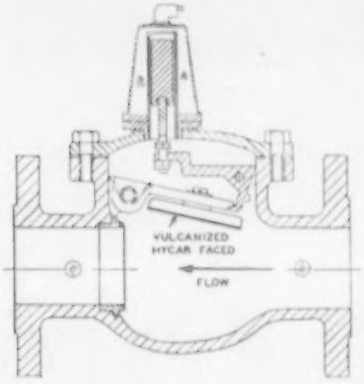
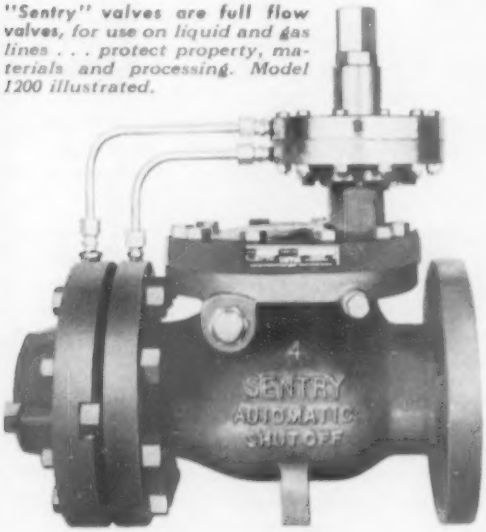


Model 1200. "Sentry" **excess flow valve** *automatically and instantaneously shuts off when the rate of flow in the line exceeds a predetermined rate.*

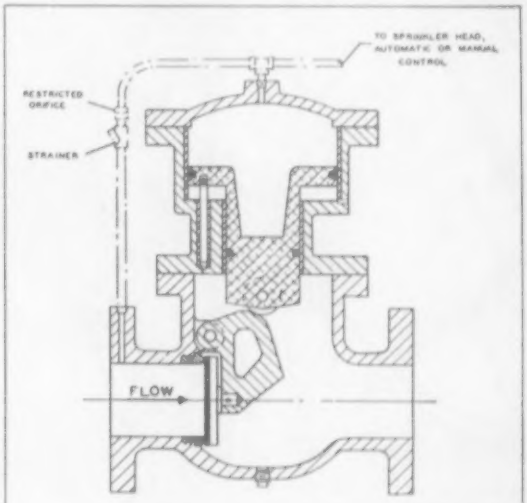


Models 1700 and 1800 "Sentry" **solenoid shut-off valves** *operate by remote electrical control automatically and instantaneously. In Model 1700, solenoid is energized, in Model 1800 solenoid is de-energized to maintain flow.*

"Sentry" valves are full flow valves, *for use on liquid and gas lines . . . protect property, materials and processing. Model 1200 illustrated.*



Other types "Sentry" Valves: high-pressure and low-pressure and over temperature shut-off valves available.



Model 3000 "Sentry" **piston operated quick-opening valve** *opens instantaneously when the pressure above piston is released. Ideal for deluge systems — and for remote opening and closing of fuel line.*

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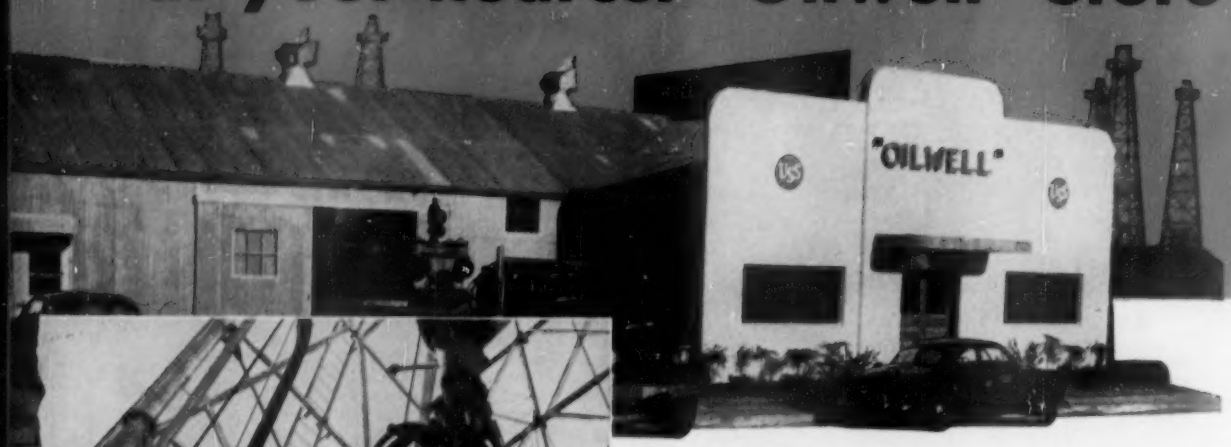
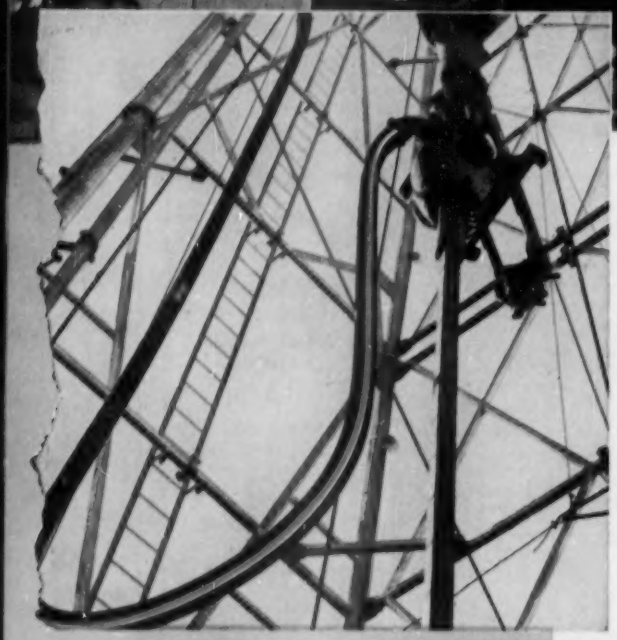
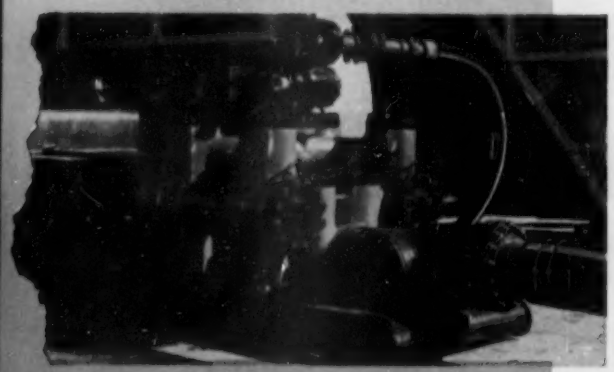




Powerflex Pressure Seal Rotary Hose, with patented forged steel couplings, combines light weight with great strength.



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THERMOID TRIOFLEX ROTARY HOSE . . . for slim-hole drilling, is reinforced with high-tensile steel wire braid. This hose is extremely flexible and resistant to kinking and coils in 36" diameter. The tube is constructed of highest quality synthetic rubber, with a tough oil and grease-resistant cover that protects the inner sections from wear. Each length is proof tested to 2000 lbs.

THERMOID MUD-FLO SUCTION HOSE . . . is made with thick oil-resistant inner tube firmly bonded to strong cotton fabric. Heavy galvanized round wire reinforcement is embedded in rubber compound to absorb pumping vibrations and provide unobstructed flow.

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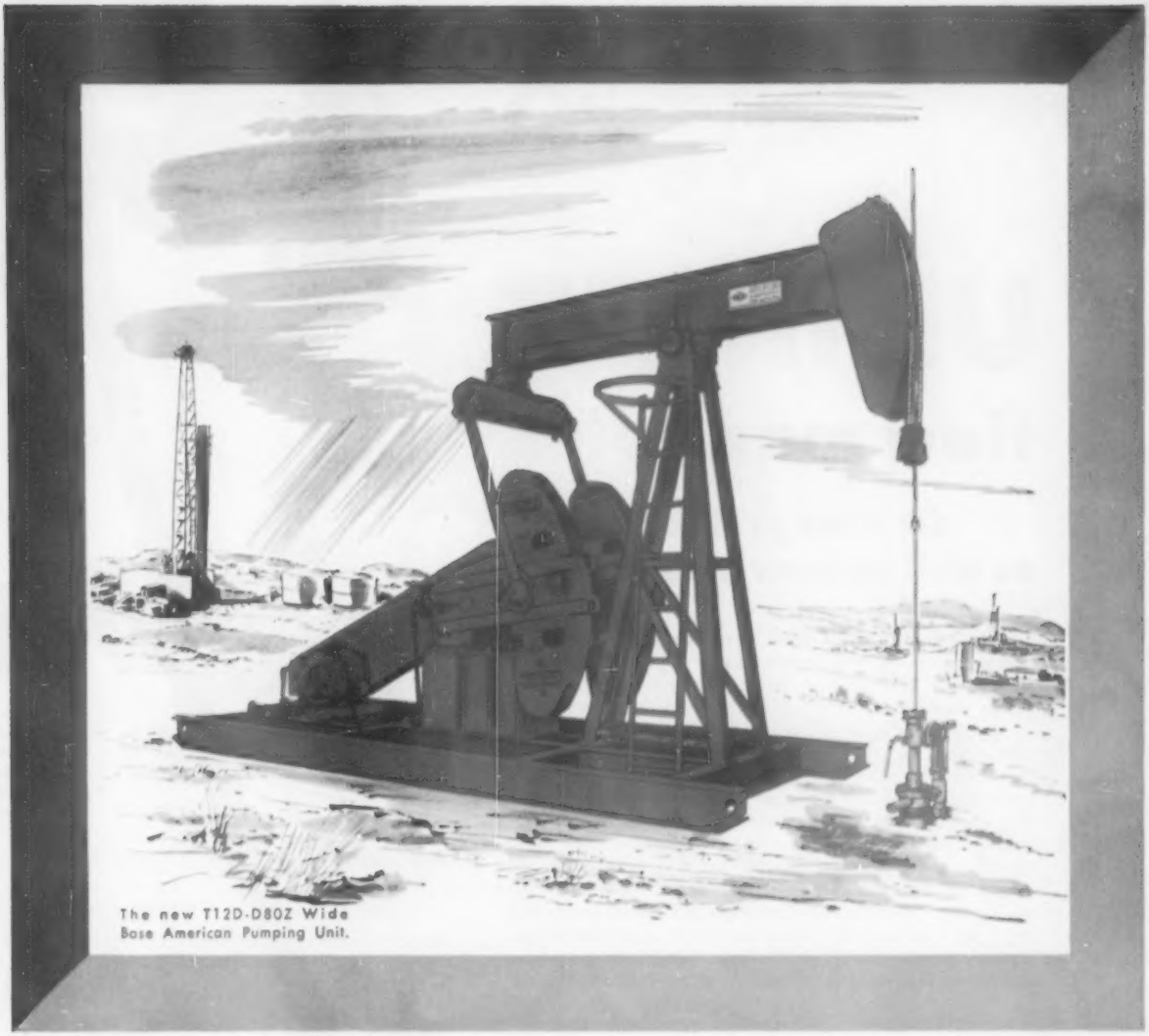

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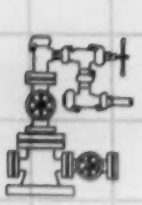

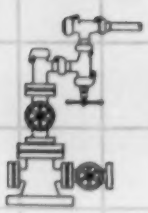

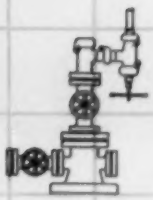

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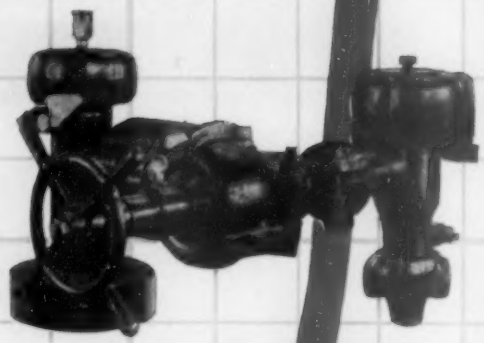

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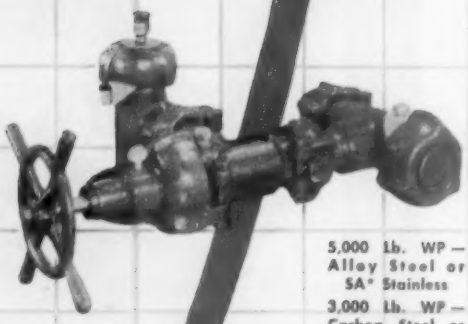

5,000 Lb. WP — Alloy Steel or SA* Stainless
3,000 Lb. WP — Carbon Steel or SA* Stainless

3,000 Lb. WP — Carbon Steel or SA* Stainless
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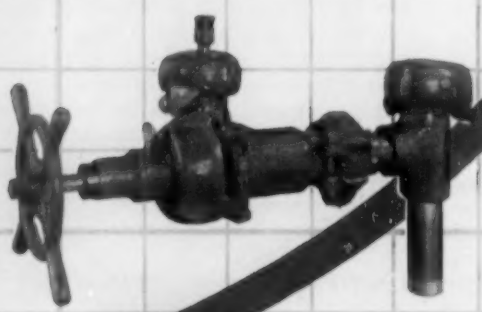

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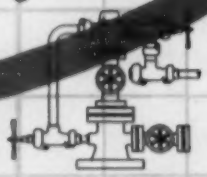
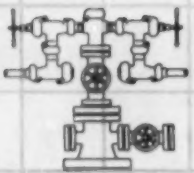
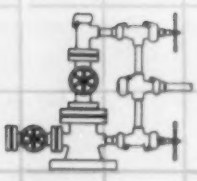






THORNHILL
P. O. BOX 1184

CRAVER CO.
HOUSTON, TEXAS

News about

B.F.Goodrich Chemical *raw materials*

Easy-to-install Geon rigid vinyl pipe lasts longer

THE exceptional physical and chemical properties of pipe and fittings made from Geon rigid vinyl resins have cut costs in many systems and made entirely new applications possible. Here are the reasons:

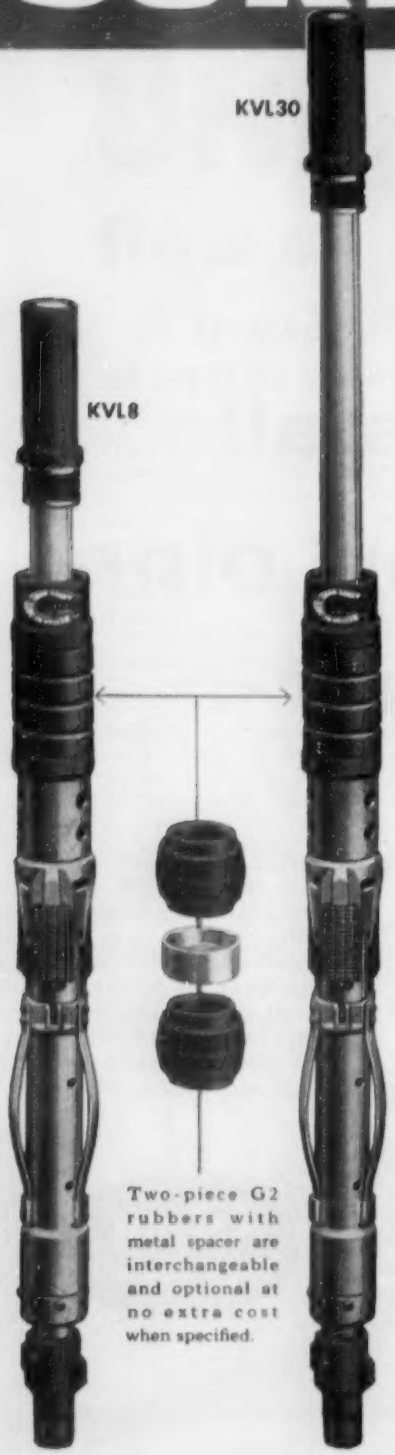
1. **Resists oil, acids, alkalis, most chemicals.**
2. **Has high tensile and impact strength.**
3. **Resists sunlight, fungi, bacteria, moisture, heat and cold.**
4. **Smooth internal surface reduces flow resistance.**
5. **Rigid enough for overhead installation with pipe supports, but flexible enough to absorb shocks.**
6. **Easy to install. Lightweight (see photo), fittings attached by solvent cementing, threading, heat welding or adhesives.**
7. **Being a non-conductor, does not support electrolytic action.**

Applications include sour crude oil lines, salt water lines, chemical plant piping, industrial cold water lines, vent pipes for acid fumes and corrosive gases. Vinegar plants, ships at sea, oil fields —all are enjoying the rewards of cheaper and easier installation, lower material cost and longer pipe life under extreme conditions. For ideas on how pipe made from Geon can help you, write Dept. DT-8, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

SAFE and SURE

GUIBERSON'S KVL PACKERS



Two-piece G2 rubbers with metal spacer are interchangeable and optional at no extra cost when specified.

With Automatic Latch

Operators who want extra assurance that a packer won't come unlatched going in, depend on Guiberson KVL packers. Rugged and durable, KVL packers have earned a reputation for dependable performance in deep and medium depth wells. These retrievable packers are easy to set and release, with ample bypass and positive seal. When running into a liner the KVL stays latched and drag springs provide an excellent guide — features operators like. For conserving gas energy and increasing production in flowing wells; for completing wells by circulation; for acidizing, repressuring and dozens of other uses, the KVL is unsurpassed.

- Made as the KVL30 with 30″ valve stroke or KVL8 with 8″ valve stroke for standard below-packer circulation. (Both packers also made with perforated mandrel for circulation above packer.) Available in casing sizes 5″ through 9⅝″.
- Valve has two independent sealing elements, a tapered metal valve and seat and a set of oil-resistant seal rings, affording double-sealed protection.
- Rubbers made of special oil and gas resistant compound. Will not vulcanize to casing — recover original shape when released.

THE
GUIBERSON
CORPORATION

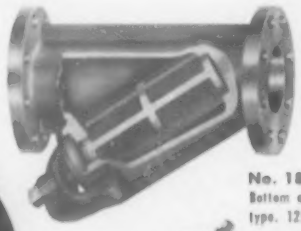
ESTABLISHED 1919 • DALLAS, TEXAS, U. S. A.

Sold By Leading Oil Field Supply Stores Everywhere

A Contamination-Free Product

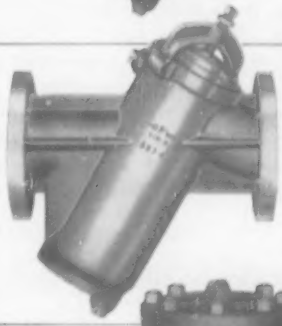
No. 187
Bottom Outlet Type

WITH OPW line strainers

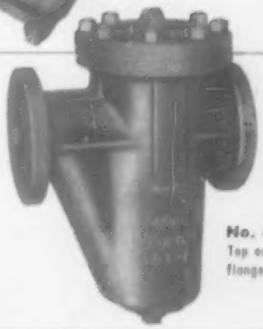


No. 187-F
Bottom opening
type. 125 pound.

No. 387
Top outlet type.
125 pound.



No. 387-F
Top outlet type
flanged. 125 pound.



No. 487-F
Top outlet type
flanged. 200 pound.

Is your product clean enough, your pump, meter and loading valve protected against scale, grit, dirt, rust and other foreign materials?

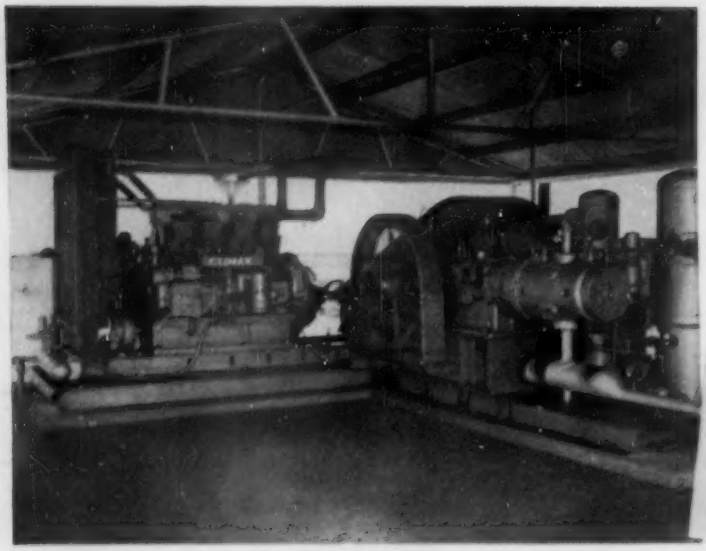
Be sure! Install OPW Line Strainers in any pipe line system for a cleaner product. Tight fit of cage and screen assures all product passing through strainer. Screen areas are many times pipe size for full flow. The simplicity of screen removal, cleaning and replacing facilitates regular, periodic checkup in the shortest possible time.

Choose your size, type and mesh! 125-pound standard or 200-pound high pressure types. Bottom or top outlet cage, reinforced for sturdiness and precision fit. Screwed or flanged end. Flanges, bolts and gaskets to suit. Strainer meshes from 14 to 300.

OPW CORPORATION

Valves, Fittings, Assemblies for the Liquids Handling Industries

2731 Colerain Ave., Cincinnati 25, Ohio
Klrby 1-5400



One of two Climax V-85 installations at Tex-Penn's Plymouth Field near Corpus Christi, Texas. Engines drive gas compressors on a closed jet system.

A Climax V-85, 8 cylinder, 7½ x 7 engine with 2474 Cubic Inch Displacement.

Climax Engines are

FIELD RECOMMENDED

Mr. F. F. Dueser, production superintendent, states that he is "well satisfied" with his Climax engines. Both V-85 Units operate on a 24-hour per day, 365 day yearly basis and minimum downtime has been encountered since installation. "In addition, my Climax engines give excellent performance, operate at low cost per horsepower and are dependable," comments Mr. Dueser, "and I strongly recommend them for any similar oil field applications."

CHECK THESE IMPORTANT FEATURES OF CLIMAX V AND K SERIES ENGINES

- *All models have renewable cylinder sleeves.*
- *All intake and exhaust valves are free-to-rotate type.*
- *All crankshafts are supported by bearings on each side of each crankthrow.*
- *All connecting rods are rifle drilled for pressure lubrication of piston pins.*
- *All cylinder heads have Climax high-turbulence type combustion chambers which produce maximum fuel economy.*
- *All models have the Climax consistent design that makes possible maximum interchangeability of wearing parts.*

Write today for your copy of Bulletin SA-611, "Special Units for Gas Compressors."

WHERE POWER IS YOUR PROBLEM — CLIMAX IS YOUR ANSWER

climax
BLUE STREAK ENGINES

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CLIMAX ENGINE AND PUMP MFG. CO.
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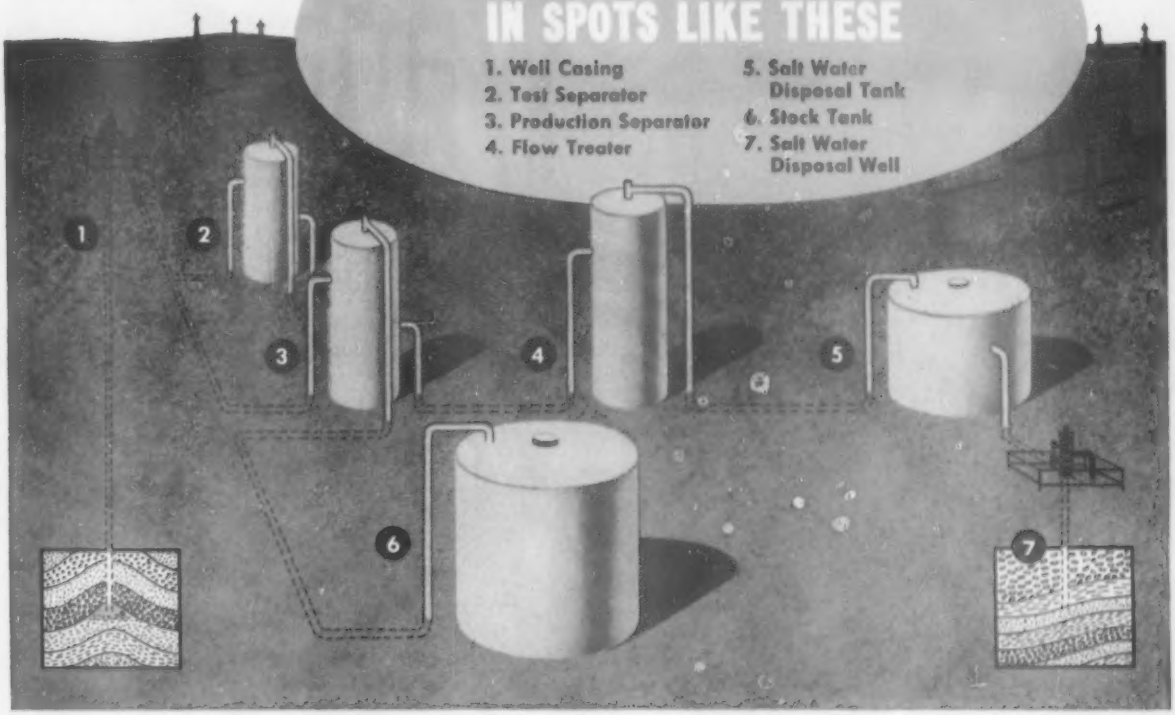
HOW TO PREVENT *Crude Oil Corrosion* IN SPOTS LIKE THESE



...WITH TARSET®

HERE'S an important new weapon for controlling costly crude oil corrosion. It's TARSET—the effective new *coal tar-epoxy resin* coating. In test after test, Tarset has proved that it can stop corrosion caused by sour crude in storage tanks and in a growing number of other pieces of crude oil handling equipment.

Tarset is the toughest, hardest coating of its kind ever produced from coal tar. It will not shatter at −30°F. or soften at 400°F. It is superior to all other coal tar coatings in its ability to adhere to metal and concrete. And Tarset is easy to apply by brush, roller or spray.

If you have a corrosion problem—above ground or below—call on *Pittsburgh*. Without obligation, our engineers will gladly tackle your specific crude oil corrosion problem . . . and come up with dollar-saving answers. Let us hear from you today.

Send for Descriptive Booklet on TARSET today

Free booklet tells how to use amazing new Tarset to reduce costly corrosion. Gives detailed description of Tarset's specifications, properties and application characteristics. Write for *your* copy today!

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

Wanted for Straight Shooting

in 16 States and Mexico

ORRIE LUTTRELL

MEN *make service!*

If he isn't the fastest gun in the West, Orrie Luttrell certainly is the shootin'est. He's *wanted* for perforating in 16 states and Old Mexico... has "notched" more than 4500 successful shootings. Orrie started back in the days when one truck made "a fleet" and when a 12-shot gun was "heavy artillery." He has travelled the oil country, shooting wells from 40 feet to 17,000 feet. Over the years, Orrie has rung up many a record—such as the largest number of holes shot; the deepest well to be perforated; and the deepest producing well.

BJ Service is proud of Orrie and his straight shooting—not only with a perforator but in his dealings with the customers. Orrie never promises something he can't deliver. And he always sticks to his word when a promise is made. As Orrie puts it, what counts with customers is "truth and service."

This straight shooting quality is basic with the men of BJ Service.

Call for this experienced, straight-shooting service on your next cementing, well-stimulation or wire line job. Call the men who make service...BJ Service, Inc.

BJ Service

BJ SERVICE, INC.

A SUBSIDIARY OF BORG-WARNER CORPORATION

GENERAL OFFICES:

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Service stations throughout the Pacific Coast, Rocky Mountain and Permian Basin areas

Evaporation reduced with Microballoon spheres!*

Annual loss of 13,500 barrels reduced to 2700 barrels

In this tank farm, evaporation loss has been sharply reduced by the use of a ⅜-inch layer of Microballoon spheres. Capacity of the farm is 400 thousand bbls., four tanks operating on approximately a 7 day cycle with 7 RVP oil. The fifth tank handles 4 to 5 RVP oil on a 23-25 day cycle. Pipeline rate is 40 thousand bbls. per day.

Here's evaporation control that talks money . . . an estimated $32,500 saving! And this installation paid for itself in a matter of months.

In October 1953, 22,000 pounds of Microballoon* spheres were installed in the five cone-roofed tanks at the Salem, Illinois station of the Sohio Pipeline Company. Two years later this same installation is still operating *without additional investment!*

Microballoon spheres are non-abrading, won't harm tanks, pipes or pumping equipment. For further information, write Bakelite Company, or *Chicago Bridge & Iron Company*, Chicago 4, Ill.

*Registered trade-mark of The Standard Oil Co. (Ohio)

for evaporation control...

BAKELITE BRAND RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

A new look in pipe lines . . .

"THE WORLD'S

FIRST" *installation of*

NATIONAL EXPANDED SEAMLESS LINE PIPE

a 252-mile line from Hebron, Pa., to Greenwich, Conn.

Expanded Seamless Line Pipe is a new product of National Tube—never before used in a pipeline installation. The 252-mile, 24-inch line was installed by Tennessee Gas Transmission Company, from their Hebron underground storage field near Coudersport, Pennsylvania, to Greenwich, Connecticut.

The pipe was apportioned in the following sizes:

205 miles of 24-inch, ⅜-inch wall
46 miles of 24-inch, ½-inch wall
1.5 miles of 24-inch, ⅝-inch wall

* * *

Not only is National *Expanded Seamless* easier to weld at all temperatures, but it possesses greater, more uniform strength than ordinary line pipe. This high strength permits safer operation at high pressures under all conditions. And the uniform internal size of *Expanded Seamless* facilitates field line-up and welding. It is available in sizes 16-in. to 26-in. O.D., in a full range of wall thicknesses.

On all counts, National *Expanded Seamless* Pipe is absolutely unparalleled for line installations. For improved efficiency and greater economy on *your* next line pipe job, plan to install National *Expanded Seamless* Line Pipe.

IN PIPE LINES TOO . . . SEAMLESS DOES IT BETTER

The pipe laid in the populated areas was yard-coated with coal-tar enamel, glass mat, and asbestos felt. Bending was accomplished by a bending machine at the yard.

Possessing superior welding characteristics, National *Expanded Seamless* l ½-inch wall was welded with five to six beads; in ⅝-inch wall with fou beads. The pipe was delivered with a 30° bevel.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

As wells get deeper, men string more lines in the blocks — but there is still only ONE LINE down to the drum.

How tough can that one line be? How many round trips can be made with safety? How can a man reduce his wire rope costs?

The most successful way to resolve such questions is to standardize on J&L wire rope backed by J&L Supply service.

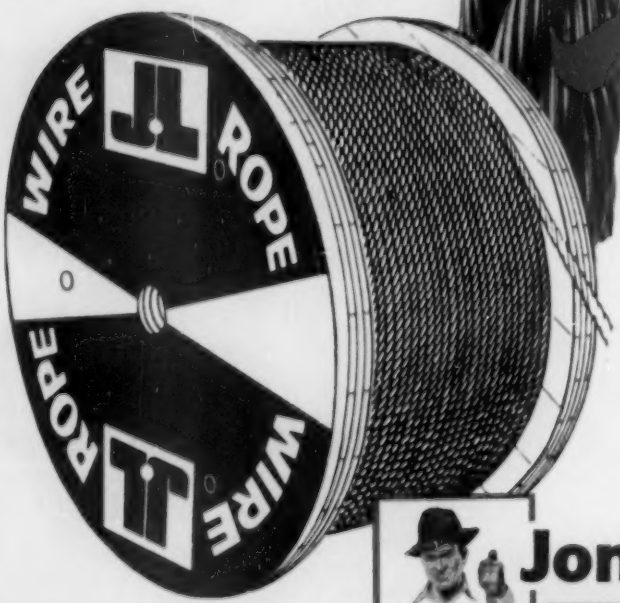
You want your rotary lines to be stronger and more flexible. You want more successful resistance to crushing and abrasion. You want the vendor to be interested and helpful.

For these reasons, get your J&L store on the telephone.

HOW TO *Save*

On Rotary Wire Lines

IWRC — Fiber Core — SpringKore



J&L SUPPLY

"...here's MY warehouse!"

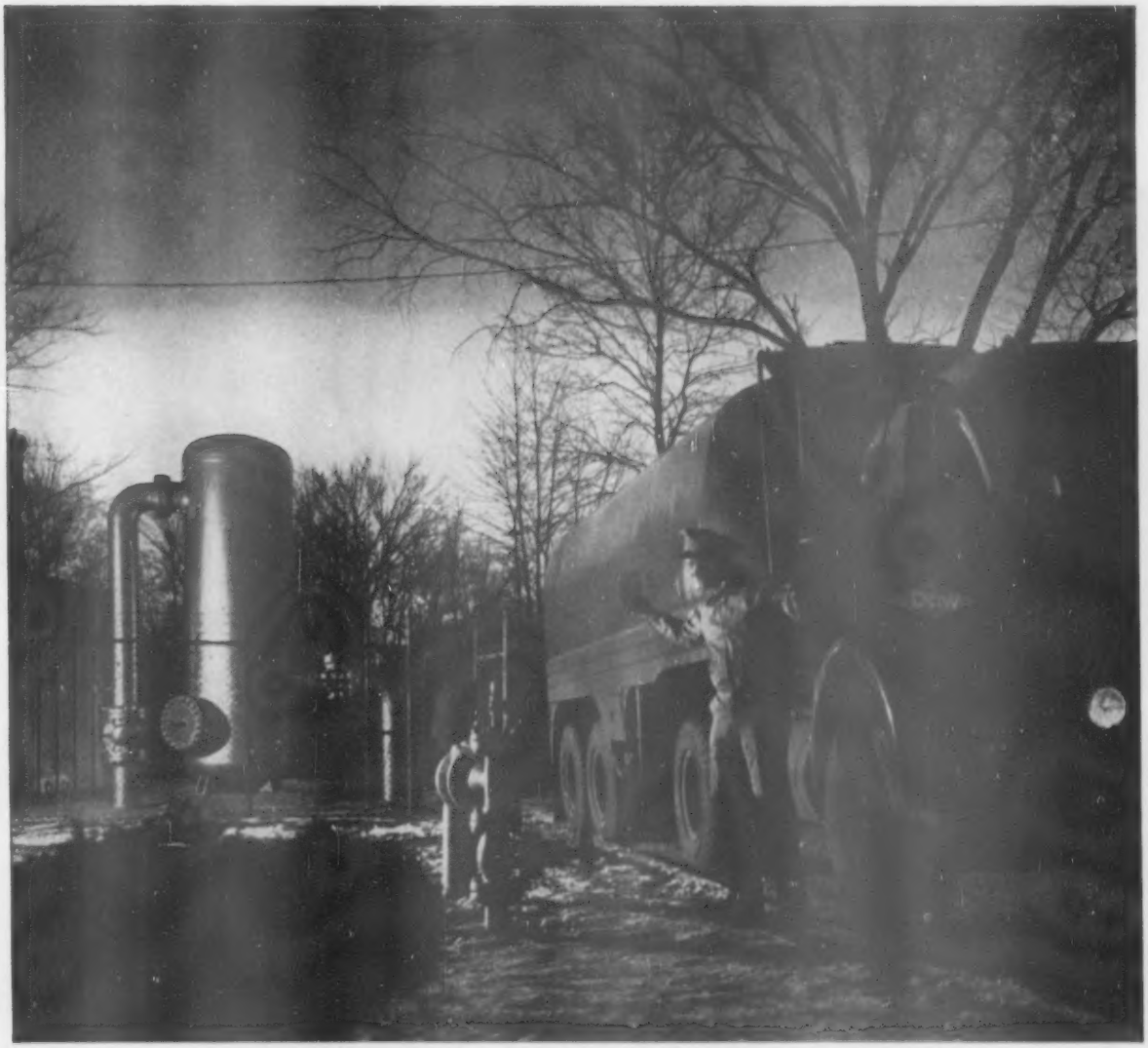
Jones & Laughlin

SUPPLY DIVISION — Tulsa

SERVING THE UNITED STATES AND CANADA

11-C

DOW



Dow tank trucks provide fast, efficient service on diethylene glycol, triethylene, monoethanolamine, diethanolamine and other chemicals for treating natural gas.

you get

DOW DIETHYLENE GLYCOL WHEN AND WHERE YOU NEED IT

Fast Delivery to Well, Pipeline Substation or Storage Facility from Conveniently Located Dow Terminals

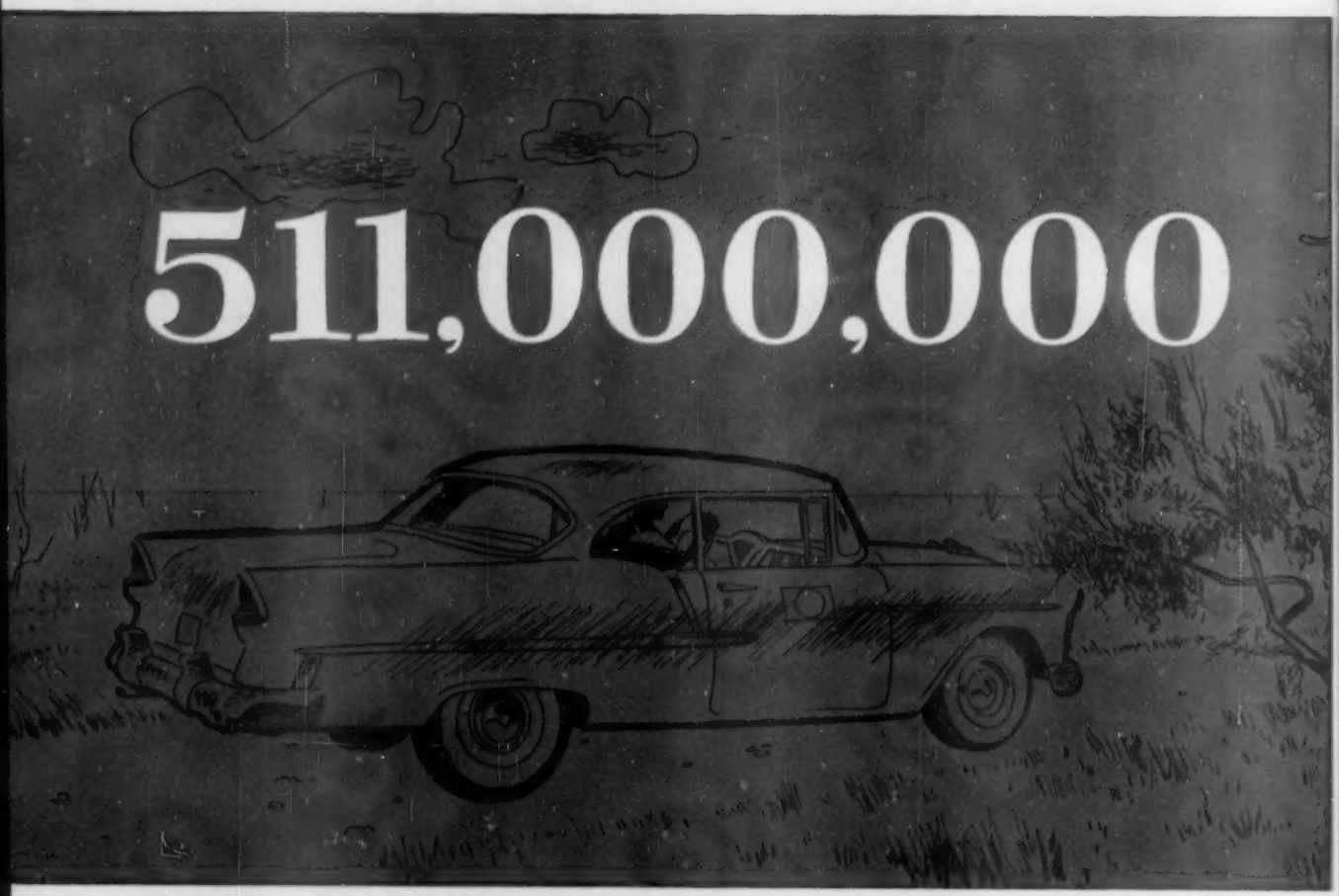
A big part of the gas dehydrating problem is solved by having an adequate supply of the right chemical at the right place whenever you need it. Diethylene glycol and other gas-treating chemicals may be needed anywhere along the line from well to consumer.

The many Dow shipping points are one reason why Dow service on diethylene glycol, triethylene glycol, monoethanolamine and diethanolamine is unexcelled. It permits you to keep your inventory at a minimum, and it assures rapid handling and prompt delivery of your order.

Ask about the many other advantages you get when you buy gas-treating chemicals direct from Dow. Contact your nearest Dow sales office or THE DOW CHEMICAL COMPANY, Midland, Michigan.

you can depend on DOW CHEMICALS DOW

We* give extrao



Thanks to the spur of keen competition among our members—and their innate desire to back up their continually improved products and special services with helpful technical assistance

. . . we* give our customers outstanding service—as proved by the fact that our service cars, trucks, and pickups travel *511,000,000 service miles a year;*

. . . we* back up our products and special services with *9,000 engineers,* composed of research scientists, development engineers, metallurgists, production engineers, and field service engineers;

. . . we* back up our products and services with *plants and equipment worth billions of dollars* in order to supply our customers with constantly improved equipment and services in *quantities wanted . . . when wanted . . . where wanted.*

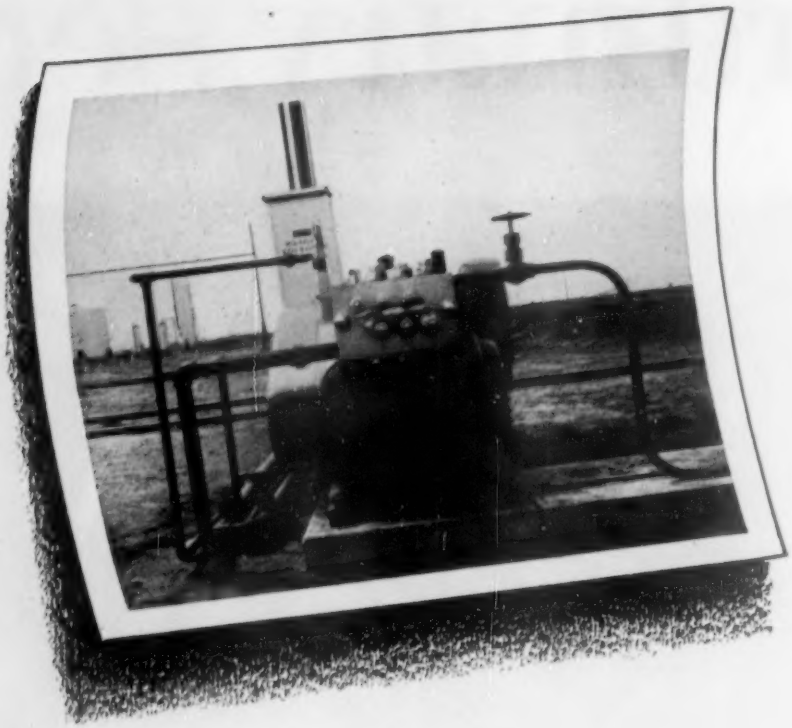
*Manufacturers . . . Supply Companies . . . Service Companies

rdinary service

P.E.S.A.*

*PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

Composed of: manufacturers whose plants make the finest precision equipment . . . supply stores who add two other ingredients of value — where you want it — when you want it. . service companies who make available to their customers the practical results of the theoretical research of some of the most brilliant scientific and technical men in the world.



You can depend on GAULIN TRIPLEX PUMPS to keep on working...

Horizontal design of these hydraulic pumping units completely separates cylinder from crankcase, preventing any product leakage to crankcase.

Plexiglas well covers give an instant visual check of cylinder plunger and packing operation.

Corrosion-proof cylinder is made of stainless. Hardened stainless or ceramic plungers available.

Spring-loaded plunger packing is self-adjusting, self-sealing, eliminating the human element.

API ball valves and removable seats permit quick adjustment in the field.

Wide volume and pressure ranges are provided by Gaulins because plunger sizes and drive speeds can be quickly changed in the field.

Manton-Gaulin
MANUFACTURING COMPANY, INC.
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MANTON-GAULIN MANUFACTURING CO., INC., LA HABRA, CALIFORNIA
M. Lee Walraven, Mgr Oil Field Sales (Oxford 7-6334) (Long Beach 4-1396)

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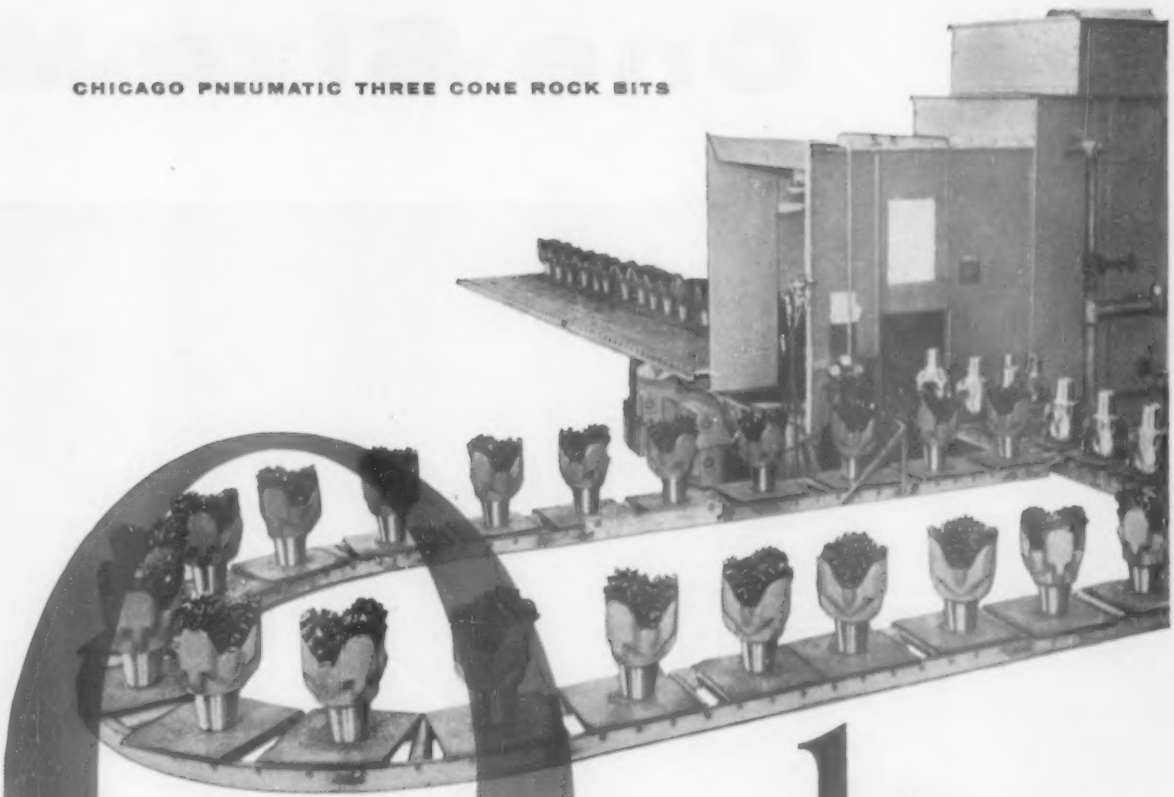
Gaulin

CHICAGO PNEUMATIC THREE CONE ROCK BITS



Quality

in the making

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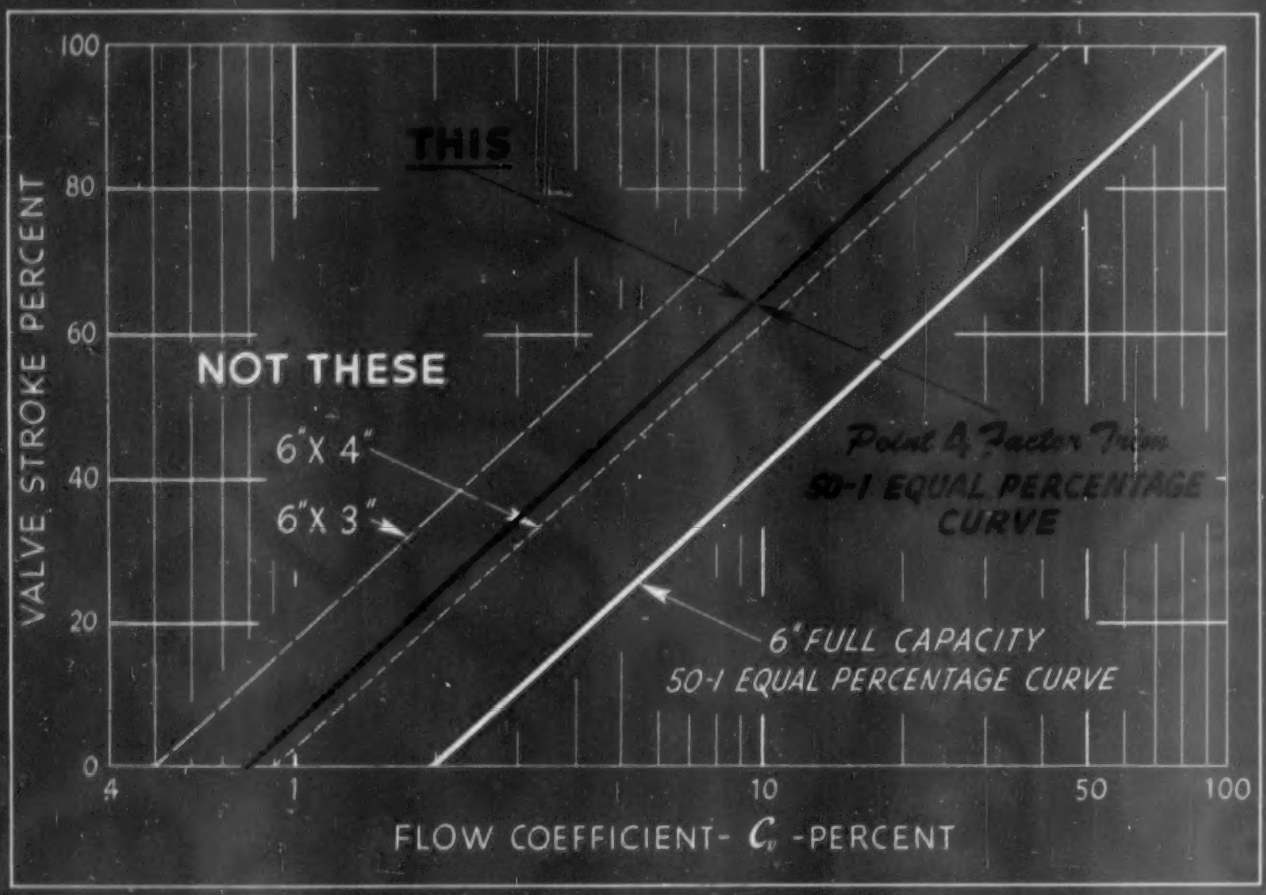
One Size...



A HIGH C_Q (Quality Coefficient) PRODUCT

Point 4 Factor Trim

is the answer to those few types of applications where reduced capacity trim is required. It is available in V-port and solid turned designs for double or single seated valves and in a wide variety of materials. Send for Data Sheet No. 10-5.

Not Two

Masoneilan *Point 4 Factor Trim* offers the ONLY REALISTIC approach to selection of reduced capacity trim

It is a DEMONSTRABLE Fact that for a given size top-and-bottom guided valve only *one* size reduced capacity trim is:

Desirable from an engineering standpoint because . . .

(a) properly designed wide-range valves with full capacity trim will handle a vast majority of control problems.

(b) if any reduction is required, it must be substantial to be of any advantage.

(c) any sound design must be based on a reduction in seat ring diameter.

(d) rule-of-thumb trim reductions based on nominal *pipe* sizes are unnecessary and merely complicate the sizing problem.

Practical from manufacturing and operating standpoint because . . .

(a) mechanical strength is retained with standard guide and stem diameters and standard stroke, in combination with maximum reduction in seat diameter.

(b) reduction in number of parts simplifies stock problem.

(c) forged and cast forms insure complete uniformity of parts.

MASONEILAN

MASON-NEILAN

Division of Worthington Corporation

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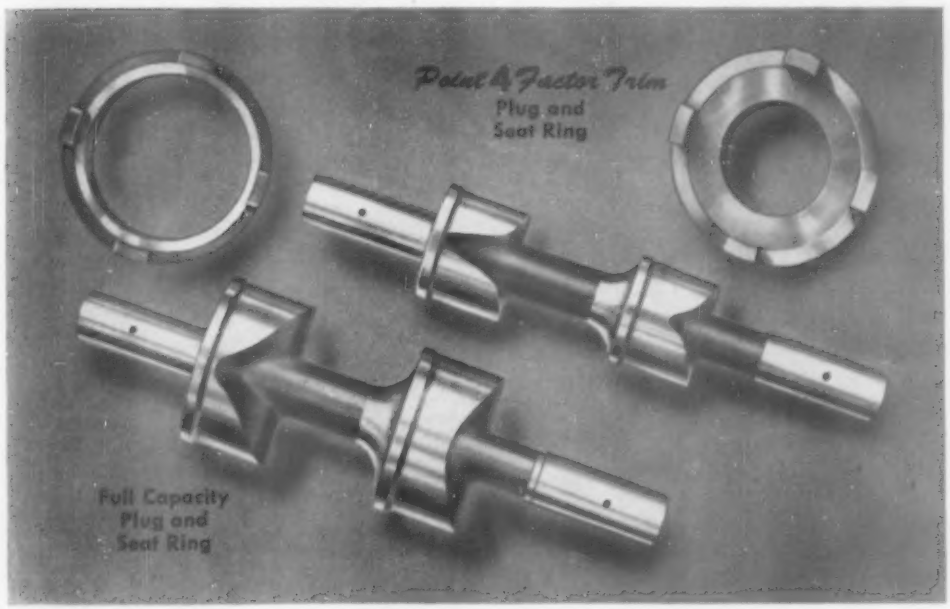
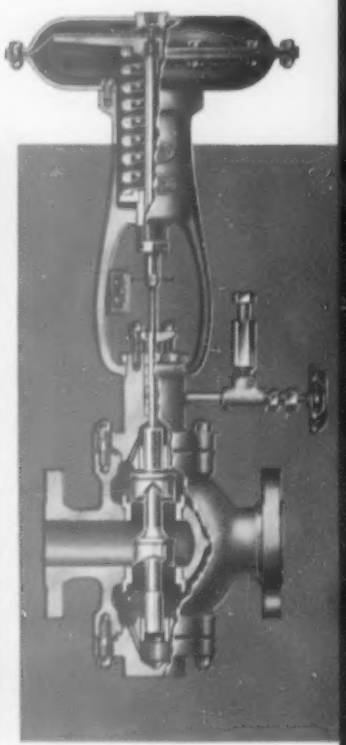


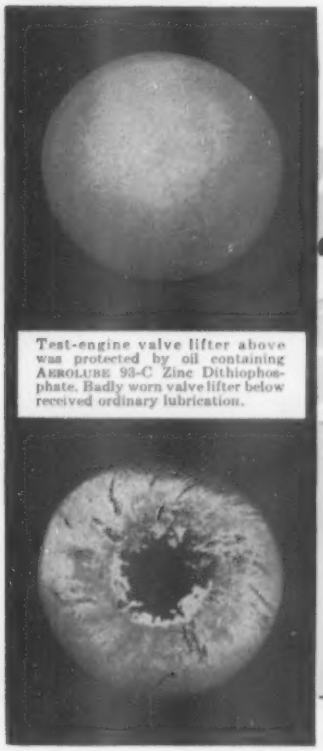


The odds are it's a LUFKIN

AEROLUBE® 93-C

ZINC DITHIOPHOSPHATE

Fights Wear... cuts engine repair



Test-engine valve lifter above was protected by oil containing AEROLUBE 93-C Zinc Dithiophosphate. Badly worn valve lifter below received ordinary lubrication.

Nine out of ten new cars today are delivered with zinc dithiophosphate in the initial fill or "break-in" oil.

The reason? Major automotive manufacturers have found zinc dithiophosphate the most effective wear inhibitor, particularly in the valve train mechanisms of modern V-8 high-compression engines.

Best of the zinc dithiophosphates is Cyanamid's AEROLUBE 93-C, specially modified to give superior antiwear characteristics. It also controls oil oxidation and checks formation of oil-insoluble sludges and varnishes. It retards formation of peroxides and organic acids that corrode cadmium-silver and copper-lead bearings.

Very light in color, compatible with all lube oil stocks and other additives, AEROLUBE 93-C may be used alone for API Service MM and initial fill requirements, or with detergents such as AEROLUBE 90 for heavy-duty formulations.

Whether you are formulating lube oil for initial fill or day-to-day service, try AEROLUBE 93-C Zinc Dithiophosphate for better control of wear, oil oxidation and bearing corrosion.

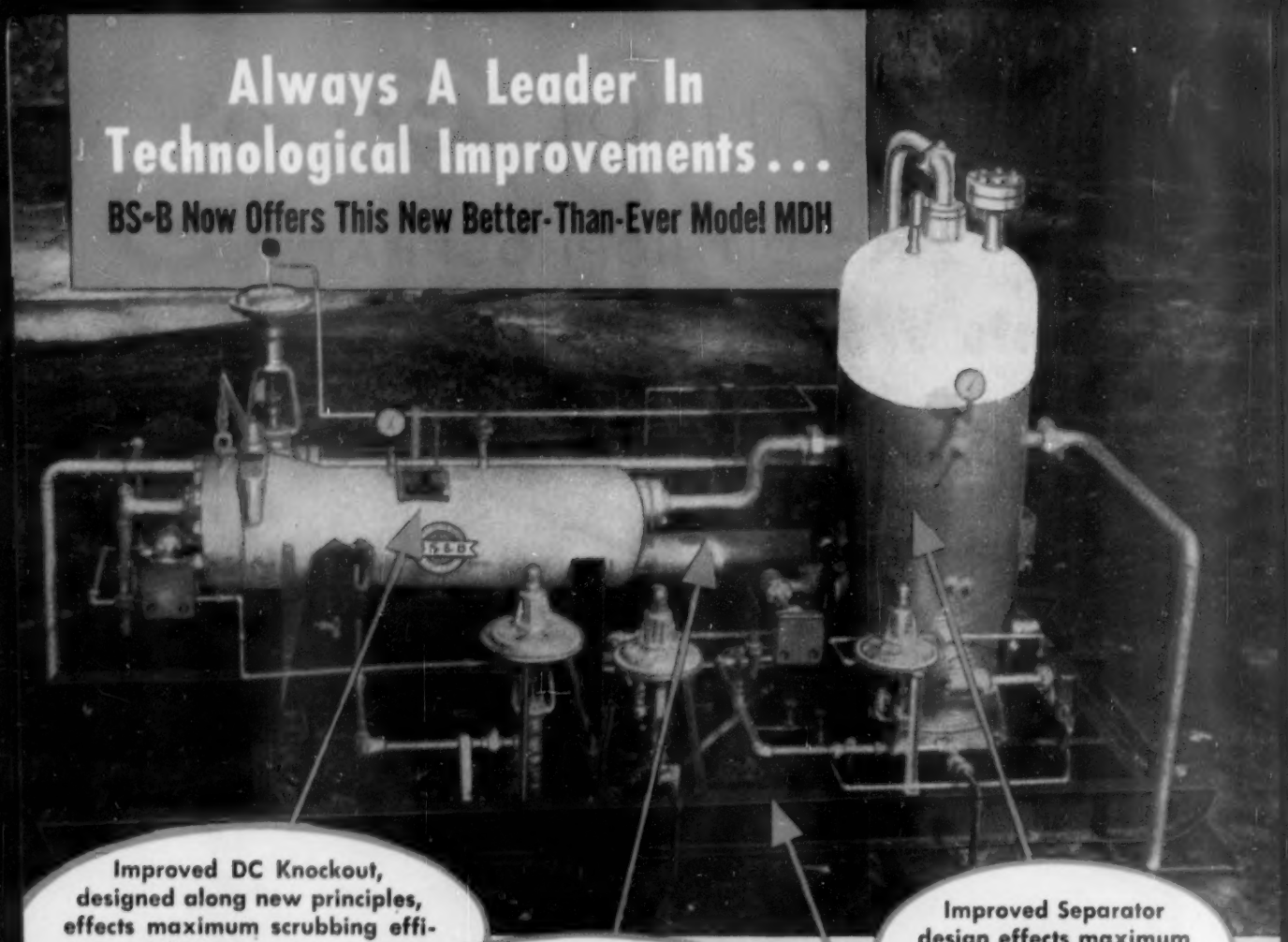
CYANAMID

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

Always A Leader In Technological Improvements...

BS&B Now Offers This New Better-Than-Ever Model MDH



Improved DC Knockout, designed along new principles, effects maximum scrubbing efficiency. Eliminates wax and salt water problems.

Efficient heat exchanger, designed specifically for this unit, achieves maximum cooling with minimum pressure drop through counterflow with cold sales gas.

Improved Separator design effects maximum separation of liquids, hydrates and gas.

Skid mounted in a compact assembly that permits shipment of the completely assembled unit. Field hook-up requires only four connections.

BS&B COLD-FRAC SYSTEM

No matter how good a new piece of BS&B equipment may be when first introduced, we are constantly seeking ways and means, born of our field experience and engineering know-how, to make it even better.

While other manufacturers are still offering the same low temperature separation systems they started out with, BS&B can now offer this proved *new* Model MDH COLD-FRAC System with improved features.

For the small lease operator, the BS&B ECON-O-MAX unit offers the same improved separator design as the larger MDH unit. Ask your BS&B Representative for details.

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Oil and Gas Equipment Division, Dept. 1-A7

1708 West Main Street — Oklahoma City, Oklahoma

You get more than gas treating chemicals from CARBIDE...

CARBIDE'S mono- or diethanolamine give you excellent removal of CO_2 and H_2S. By converting the extracted H_2S to sulfur or H_2SO_4, you benefit by recovering a valuable product—thus reducing your operating costs.

CARBIDE'S di- or triethylene glycol remove H_2O economically from gas streams. The low initial investment and low operating costs of glycol type plants provide minimum dehydration charges.

Plus Benefits

- Technical data gathered from 22 years experience producing and supplying gas treating chemicals. These data can help you in construction of new facilities, the enlargement of present equipment and in securing trouble free performance of existing plants.
- Technical help from field representatives and service laboratories.
- Fast delivery from warehouses located near major gas fields.
- Constant source of supply.

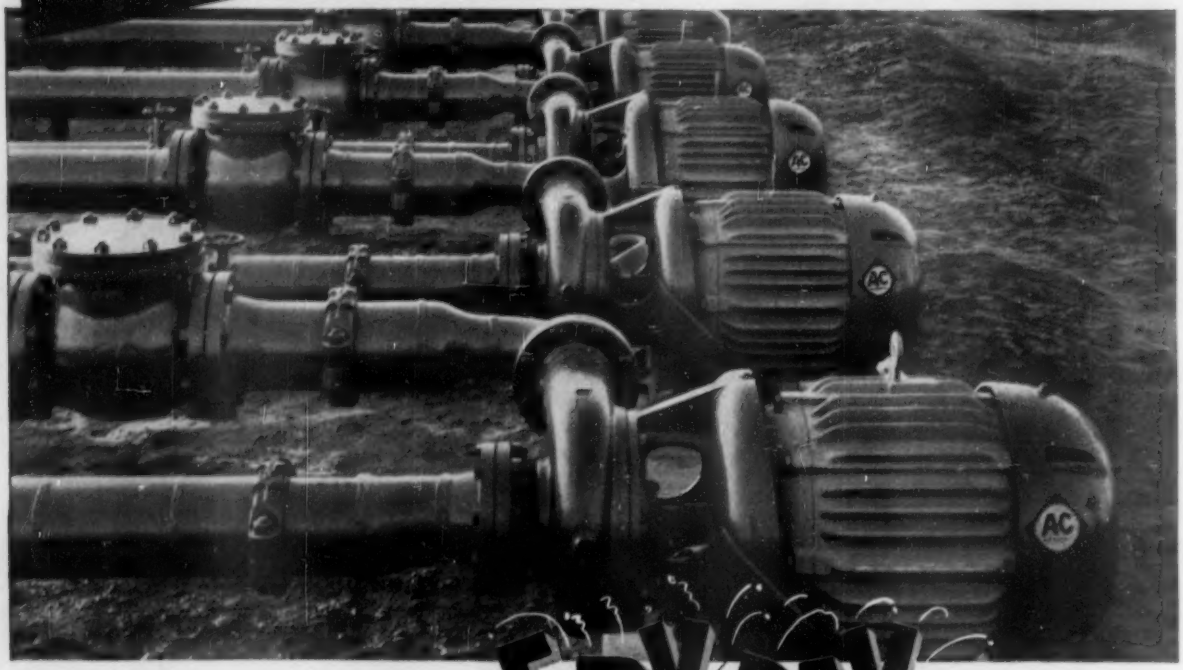
Find out for yourself how CARBIDE can help you. Write today to Carbide and Carbon Chemicals Company, Room 308, Department H, 30 East 42nd Street, New York 17, New York.

In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal. In Western Canada: Harrisons and Crossfield.

CARBIDE AND CARBON CHEMICALS

Carbide and Carbon Chemicals Company
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**



No Day is FRYDAY

with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result—you expect and get longer motor life.

The engineered partner of A-C motors is Allis-Chalmers control.

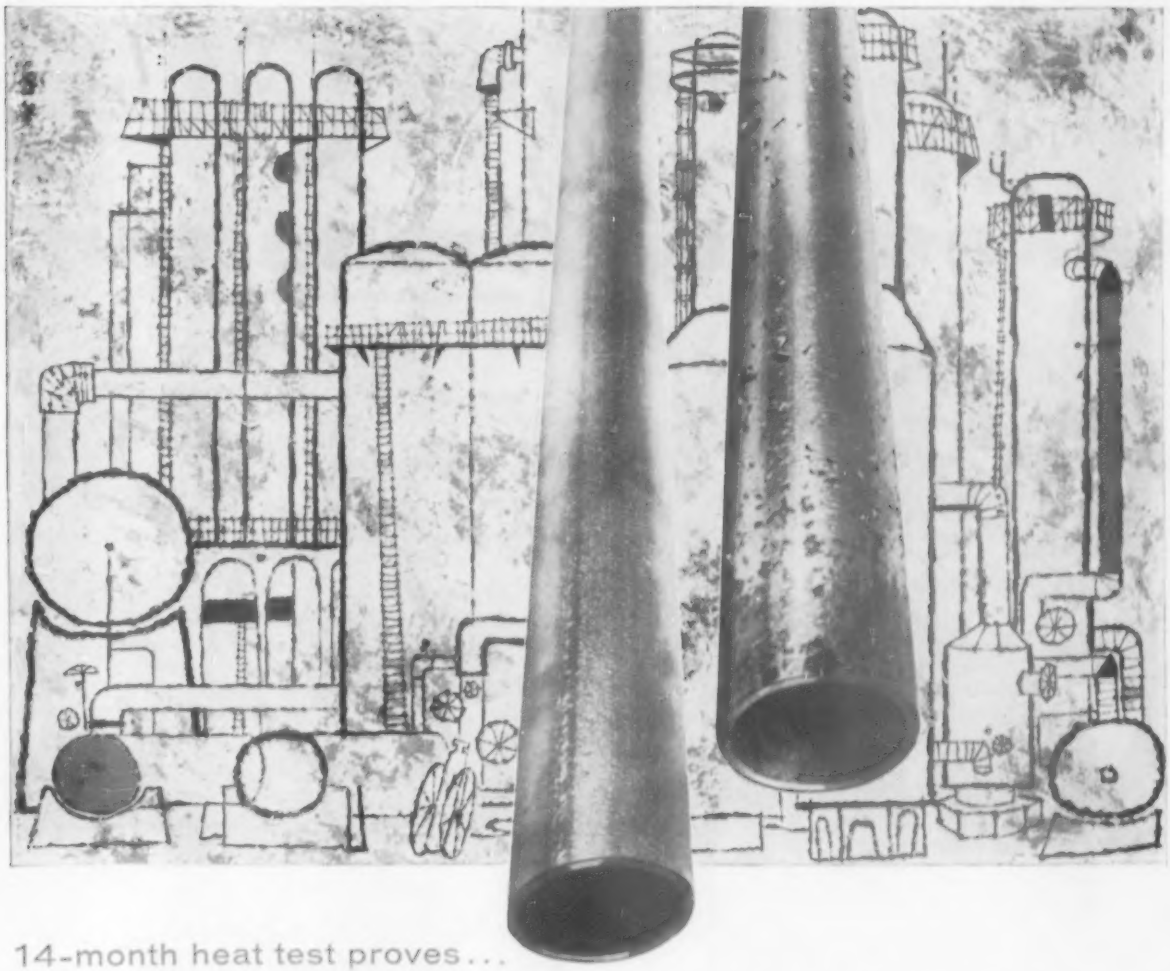
Get Complete Information

As a new machinery component or as replacement, specify Allis-Chalmers. Discuss your particular application with your nearby A-C distributor, A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4853



14-month heat test proves...

Sili-Kool Aluminum Paint superior to ordinary paint for "hot" surfaces

Exhaustive tests under actual operating conditions dramatically prove Sili-Kool Aluminum Paint's ability to give full protection despite extreme heat and exposure. The two sections of pipe, shown above, were in identical service, carrying hot air (up to 1600°F) in the most unfavorable weather conditions. The pipe on the right was painted with an ordinary heat resistant paint. The pipe on the left was painted with Silicone High Heat Paint pigmented with the best silicone and aluminum pigments. After fourteen months of constant high heat service, the pipe treated with Sili-Kool Aluminum Paint is entirely free from oxidation, corrosion and rust while the other pipe is dangerously corroded. Sili-Kool High Heat Paint, pigmented with ALCOA® Aluminum, is manufactured by the C. H. DRAGERT COMPANY, INC., Dallas, Texas.

ALCOA does not make paint, but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by your paint manufacturer to solve individual problems. Paints made to these formulas actually cost less, last longer, give utmost protection against heat, cold, sun, rain, smoke and fumes.

Write today for our two FREE booklets, *Painting With Aluminum* and *Aluminum Asphalt Roof Coatings Make Time Stand Still.* They contain valuable, up-to-date information on all types of aluminum paint and aluminum asphalt coatings. Use the coupon.

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

PIGMENTED WITH
ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America
Paint Service Bureau
1792-G Alcoa Building, Pittsburgh 19, Pa.
Please send me your FREE booklets:
☐ Painting With Aluminum
☐ Aluminum Asphalt Roof Coatings Make Time Stand Still
I am interested in protecting _____
Name _____
Company _____
Address _____
City _____ Zone _____ State _____

The New Clark Model CFA

takes the belts out

of compressing

That's right! The new Clark CFA packaged compressor doesn't require belts, jackshafts, countershafts, bevel gears, helical gears or any other type of gear or step-down device to drive it because it's direct-driven. Compressor and engine operate at a modern 1000 R.P.M. . . . that means only a simple rubber block type of coupling is used between the compressor and engine. The foot-per-minute piston speed is less than on many large stationary compressors. That's assurance of long cylinder life.

Vibration is virtually non-existent in the CFA. The Clark Balanced/Opposed design eliminates unbalanced forces and vibration. It won't "travel or walk away", even if operated on a glass-smooth floor. You can set it and forget it. In the field there is no need for a dozen or more yards of concrete to hold it down . . . use just enough to level it, that's all!

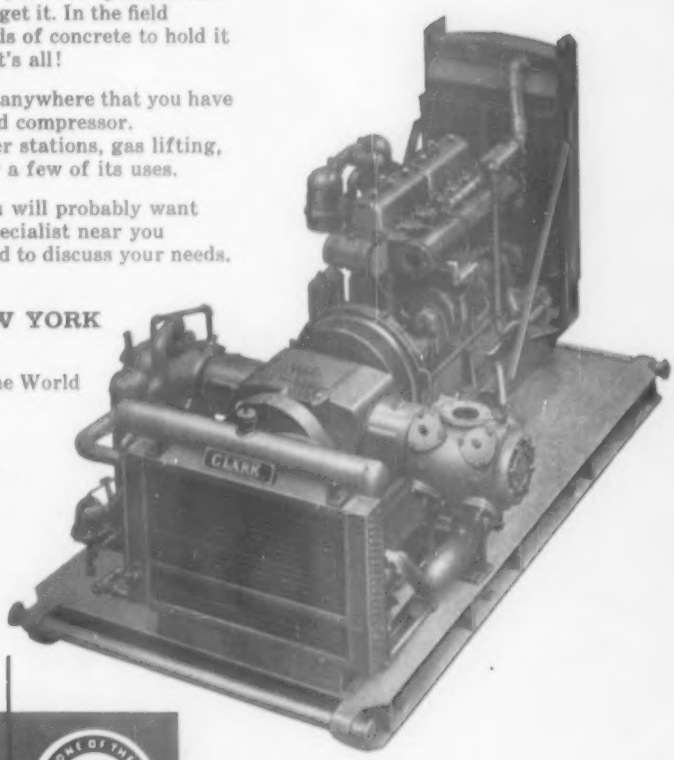
Where can the CFA be used? Practically anywhere that you have a need for a 75-200 horsepower packaged compressor. Boosting into gathering lines or to larger stations, gas lifting, pipeline testing and air drilling are only a few of its uses.

There are many added features that you will probably want to know about. There is a Clark CFA specialist near you who has all the facts and would be pleased to discuss your needs. Don't delay—call today.

CLARK BROS. CO., OLEAN, NEW YORK

One of the Dresser Industries

Offices in Principal Cities Throughout the World



Clark 175 BHP CFA-2 Balanced/Opposed Packaged Compressor station.

CLARK®

ONE OF THE DRESSER INDUSTRIES

Packaged Field Compressors

MUELLER®

A-2 Drilling and Tapping Machine

Drills and taps lines with diameter 4" and up. Inserts Mueller threaded No-Blo® fittings up to 2" under pressures to 200 p.s.i.

MAKE CONNECTIONS UNDER PRESSURE— WITHOUT WELDING

Make permanent connections up to 2" without welding and without loss of fluid. Use the Mueller A-2 Drilling and Tapping Machine.

An internal valve in the A-2 machine opens to permit the drilling, tapping and inserting operations to be done under pressure. When valve is closed, upper section of machine is removed and fitting is attached to machine boring bar. Upper section is remounted to valve section, valve is opened and fitting is inserted under pressure. Entire machine is then removed, fitting is tightened solidly. Line is connected to fitting and integral valve in fitting is opened, putting line in service.

Special Valve Tee

Used for thin wall or small diameter pipe. Threaded inlet with special compression joint of stainless steel-encased-neoprene gasket tightens down against pipe for pressure-tight seal. Integral valve with metal to metal seat gives absolute shut-off. Sizes ¾" and 1".

Valve Tee

Threaded inlet. Inside or outside I.P. thread outlet in various combinations of sizes up to 2". Integral valve has metal to metal seat for positive shut-off. NOTE: When service tee is used, it is installed with deferred completion stopper in place.

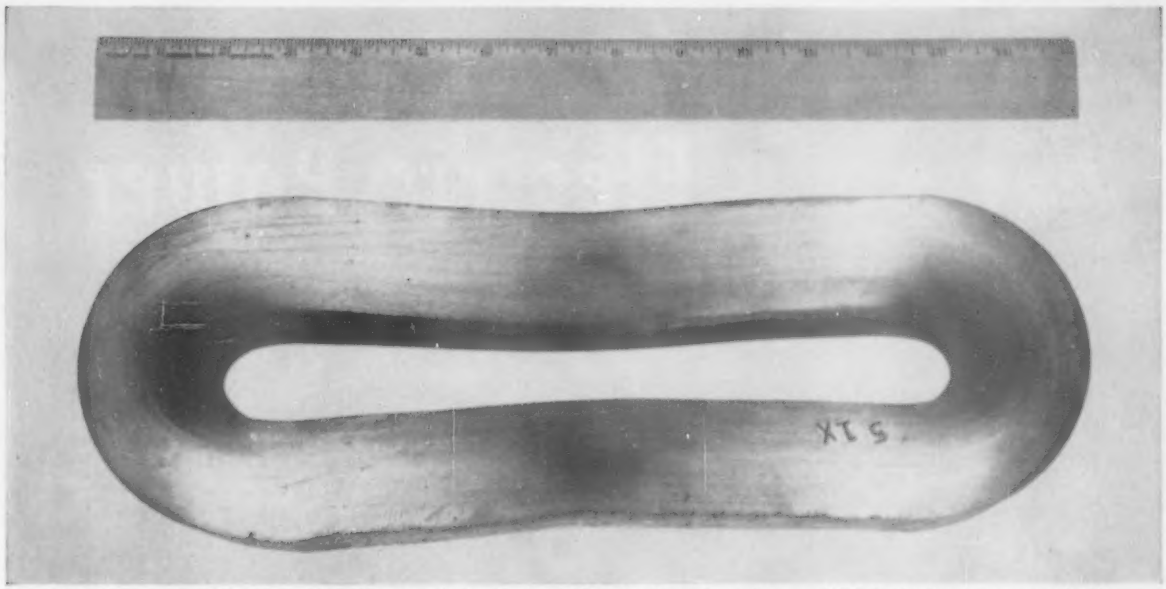
NO-BLO®

Write for complete information on these and other related Mueller No-Blo® products.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS



Flattening test of 10½" O.D. by 1.580" wall of 18-8 Cb showing the excellent ductility of large, heavy-wall Timken high temperature steel tubing.

To get the best possible tube life per dollar: *Ask the experts!*

This month's report is on:

SICROMO 7

Suggested as a substitute for steels of the 5.0 per cent chromium type for applications which require increased resistance to corrosion by hot petroleum products.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

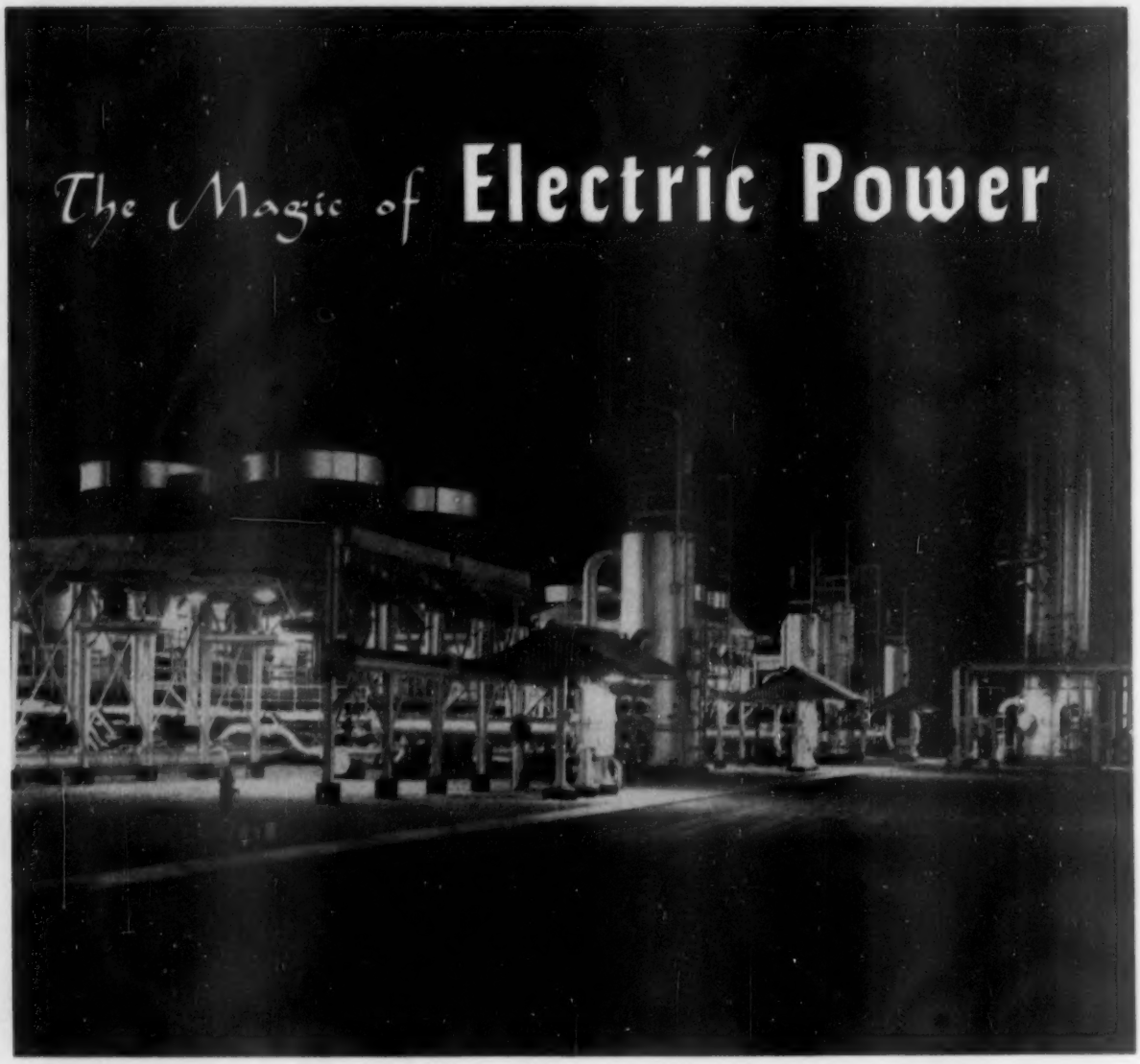
** Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

SEVERAL analyses of high-temperature steels may solve your temperature, pressure, corrosion, and oxidation problems. But to get the best life/cost ratio —the best possible tube life per dollar—there's actually only one analysis that's best for you.

To get it, ask the experts—metallurgists of The Timken Roller Bearing Company. They're recognized authorities on high-temperature steels—with more than 25 years of high-temperature steel research and experience behind them. From the 24 different analyses at their disposal, let them help you choose the *one* tube steel analysis that's best for your particular job. Whatever one you choose, you can be assured of uniform quality. That's because the Timken Company rigidly controls quality from melt shop through final tube inspection. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

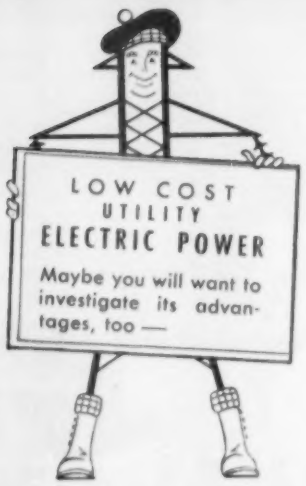
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



Service... Dependable Service

Next to a captivating sunset nothing has such a magical appearance as a giant refinery flooded by the grandeur of electric light on a pitch dark night.

Spectators view it with unceasing awe — Businessmen view it as a well-lighted, efficiently powered investment. Over 72 per cent of this nation's refineries utilize dependable purchased Electric Power. More cost conscious men are specifying it every year.



WRITE PETROLEUM ELECTRIC POWER ASSOCIATION, P. O. BOX 2771, DALLAS, TEXAS, OR CALL THE SALES ENGINEER OF YOUR LOCAL UTILITY ELECTRIC POWER COMPANY — NOW

PETROLEUM CHEMICALS DIVISION
NEWS

July ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Question Box

1. HOW can you persuade your dealers to try for increased sales volume on the basis of good management practices?
   The article at the right may give you some ideas.
2. HOW can you insure stability of distillate fuel oils?
   See below for answer and other important information concerning effective additives.
3. WHO can help you with your fuel oil stability problems?
   You can read on the next page about one of many Du Pont specialists in this field.

Need continues for additives in all types of fuel oils

The market for fuel oils is becoming more complex as the result of a demand for petroleum products tailored to specific consumer needs.

To accomplish this tailoring job, chemical additives generally offer you the easiest and most economical means . . . particularly where stability and blending compatibility problems are involved. This is true of furnace oils, diesel fuels, and residual fuels.

The various aspects of tailoring these different types of fuel oils to consumer demands through the use of additives were recently discussed in a paper by William deB. Bertolette and John D. Rogers of the Du Pont Petroleum Laboratory, presented before the Western Petroleum Refiners' Association.

Du Pont Fuel Oil Additive No. 2 (FOA-2) is ideally suited for stabilizing these fuel oils because it is an *ashless* polymeric additive. This means that it does not leave a metallic deposit or alter the chemical characteristics of the deposits that are formed.

Stabilizer and dispersant

Du Pont FOA-2 not only stabilizes the fuel to prevent sludge formation, but it also helps to rid dirty systems of any sludge that may have previously formed.

If you would like more information on Du Pont FOA-2 or a copy of the W.P.R.A. paper entitled "Improving Fuel Oils through the Use of Additives," just send your request to any of our sales offices listed on the next page.

Why are some dealers more successful than others?

The latest report — No. 5 in the Du Pont Service Station Operator Survey — reveals many controllable factors bearing on this question.

"Stay open long hours . . . advertise . . . carry a complete line of tires, batteries and accessories!"

These three practices are common to *most* of the stations which are *most* successful. There are, however, many more ingredients of success revealed in Du Pont's Service Station Operator Survey, Report No. 5, just published.

Marketing men in the industry of course are well aware of the factors which make a service station successful.

However, the highly interesting statistics developed through the survey may help them determine the degree to which each factor contributes to success, and may go far toward helping them convince dealers.

Most significant

This is the final and most significant report of the 5-part series. It discusses the *interrelationship* of various factors affecting service station operation. It may also interest you to know that in preparing this report, the results were sorted, weighed and correlated by the Univac electronic computer.

The survey data, however, should not be interpreted to show cause-and-effect relationships. And no single one of the factors analyzed, of and by itself, can guarantee success. Too, some of the variables may be considered beyond the station operator's control.

Successful stations

Yet, the report shows clearly that there is a marked difference between successful and unsuccessful stations. What's more, most of the variables considered in this report are of such a nature that

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

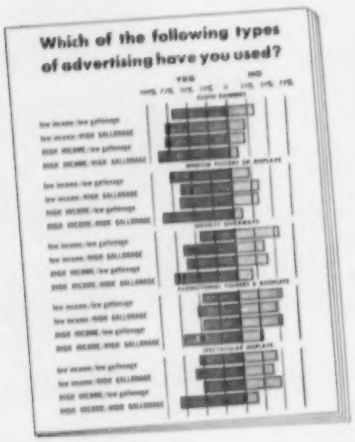
PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Dealer Success*

the service station operator has, within his power, the means for reducing any differences between his station and stations that are outstandingly more successful.

In practical terms, this means that of any representative cross-sectional group of stations, some can usually be said to be enjoying a higher income than the average if an established set of conditions is met:

1. Stay open longer.
2. Do more advertising.
3. Offer complete services.
4. Managed by operator with long experience in charge of station.
5. Managed by operator active in community projects and organizations.
6. Owner-operated.
7. Are neat.
8. Managed by better educated operator.
9. Sell TBA.
10. Price of regular gasoline thought by dealer to be lower than in his vicinity.



HERE IS a typical page from Report No. 5 on the Du Pont Service Station Operator Survey. It shows that over 40% of the high-income/high-gallonage stations spend more than $200 annually for off-station advertising. On the other hand, only 6.8% of the low-income/low-gallonage stations spend more than $200 annually for off-station advertising.

Continued middle next column

AT DU PONT PETROLEUM LABORATORY

WILLIAM deB. BERTOLETTE is Technical Service Supervisor of the Fuel Oil Group at the Du Pont Petroleum Laboratory.

He joined the Du Pont Company in 1936 after graduating from Pennsylvania State University with a B.S. degree in chemical engineering. His first assignment was at the company's Jackson Laboratory, where he did analytical work on dyes and other organic chemicals. He was then transferred to the Chambers Works where he became a chemist in the TEL area.

From 1938 to 1946, Mr. Bertolette was stationed at the Baton Rouge plant. There he was in charge of chemical control work, and later became a TEL Production Supervisor. He was transferred to production control work in Wilmington in 1946. In 1950 he joined the Technical Section.

He assumed his present position at the Petroleum Laboratory in 1955. Mr. Bertolette is a member of the American Institute of Chemical Engineers and of the Petroleum Division of the American Chemical Society.

WILLIAM deB. BERTOLETTE

Relative importance studied

Although no absolute dollar values can be assigned to the success-factors, we were able, with the help of the Univac, to analyze their importance relative to the over-all success of a number of stations in the survey sample. You will probably find the bar charts presenting these data among the most interesting and valuable parts of this Survey Report No. 5.

The report also discusses each of the factors individually . . . with the supporting evidence clearly presented in the easy-to-follow bar chart form.

Survey entirely objective

Sponsored by Du Pont, the survey was conducted on a completely impartial basis by National Analysts, Inc. It was nationwide in scope and a part of the continuing market research work conducted by the Du Pont Petroleum Chemicals Division. It follows logically the recent Du Pont survey of service station customer buying habits.

Using the scientifically accurate area sampling method, the survey consisted of personal interviews with 2,633 service station operators. This sample is representative of all the operators in the United States.

Available to marketers

The findings of this report, like the findings of the four which preceded it, are available to all oil companies.

For more information about this survey, just get in touch with one of our representatives at the nearest sales office listed below.

DU PONT
Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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LOS ANGELES 17 — 612 So. Flower St.	MAdison 5-1691	SEATTLE 3 — Room 215, 4003 Aurora Ave.	MElrose 6977
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A-2266

Printed in U. S. A.

This Ell Bolt is the Key to leak control

The patented Ell Bolt construction employed on Vogt floating head heat exchangers is the answer to re-assembly without distortion or leak development.

Cover may be removed by simply loosening the Ell Bolt nuts and disengaging the Ell Bolt heads from the "lock notches." No misplacing of Ell Bolts can result — and tightening is easy and positive — absolutely leak proof. Send for Bulletin HE-6. Address Dept. 24-XO.

Vogt

HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.

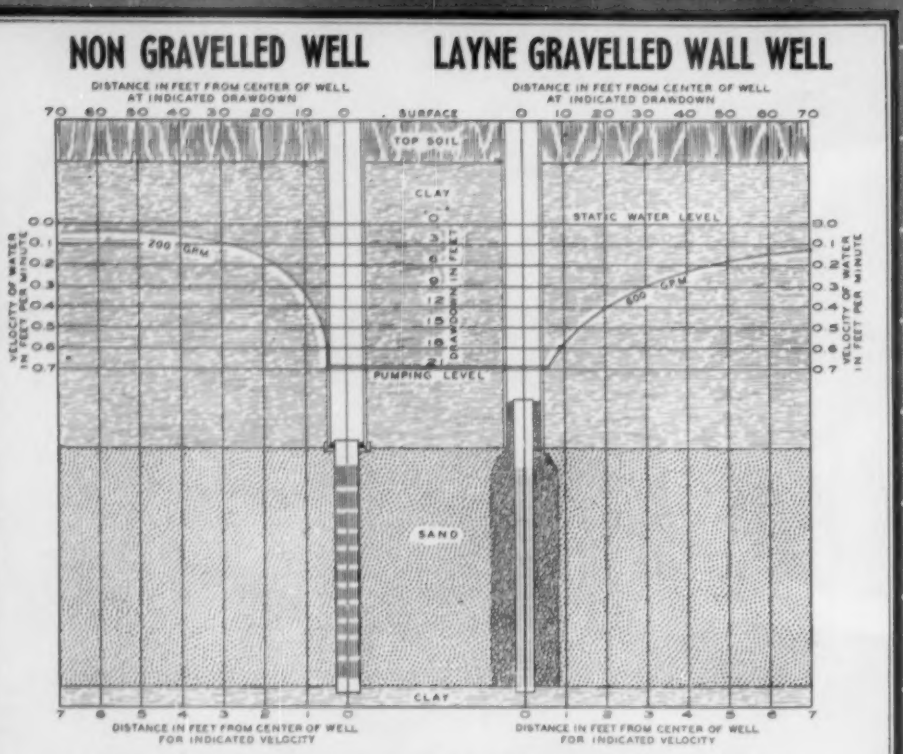
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati, San Francisco

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.

HEAT TRANSFER EQUIPMENT

GRAPHIC COMPARISON OF RESULTS



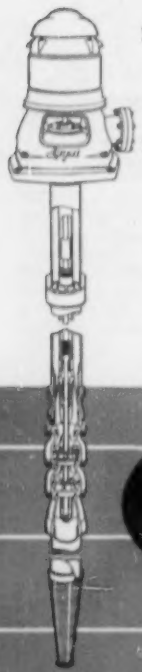
PRODUCTION AND OPERATING CHARACTERISTICS OF TWO TYPES OF WELLS

Above at right is a Layne Underreamed Gravel Wall Well equipped with Layne Shutter Screen. At left is a standard tubular, non-gravelled well with usual metal water well strainer installed in direct contact with the waterbearing sands. Both wells are twelve inches in diameter, finished in the same waterbearing aquifer and equipped with the same diameter and length of screen.

Layne Gravel Wall Wells Designed for Better Service

1. Layne shutter screen is designed specifically for use in gravel wall wells.
2. Selection of gravel and thickness of pack surrounding the screen is determined for the individual well unit after careful study of underground formations.
3. Engineering "know how" plus expert supervision eliminates guess work.

The net result is a ground water supply unit which yields more water with less draw down, consequently, low pumping cost and longer producing life—a unit which pays dividends on original cost.



LAYNE & BOWLER, INC.
MEMPHIS
General Offices and Factory

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

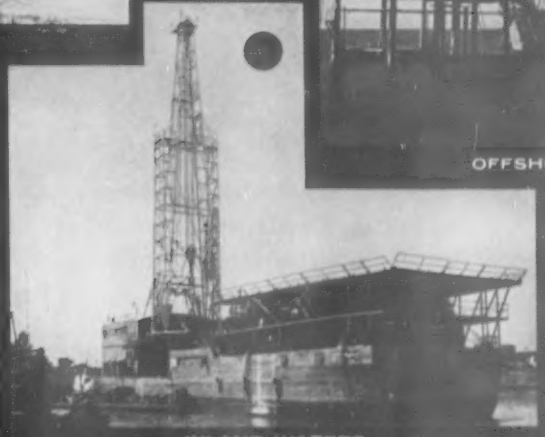
Water Wells • Vertical Turbine Pumps • Water Treatment

42 RIGS MAKE HOLE *FASTER* AND *CHEAPER* IN ANY DRILLING PROGRAM

No matter what depth or location your program calls for, Penrod has the equipment, the skilled men, the experience, to offer you big savings.

ON LAND

OFFSHORE



INLAND WATERS

MODERN EQUIPMENT – LATEST METHODS

THOROUGHLY EXPERIENCED ORGANIZATION

INDIVIDUAL SUPERVISION OF EACH RIG

2-WAY RADIO ON ALL EQUIPMENT

MODERN HOUSING FOR OPERATING PERSONNEL

HIGH PRESSURE PUMPS ON ALL RIGS

USE OF MAXIMUM DRILL COLLAR WEIGHT

CALL, WIRE OR WRITE TODAY

PENROD DRILLING COMPANY

D. K. (DEWEY) DAVIS, DRILLING SUPERINTENDENT

TELEPHONE 3-1601

418 MARKET STREET SHREVEPORT, LOUISIANA

IN THE *Octane Derby*...
no refiner will be happy .

Like it or not, every refiner today must look to his octanes. As a matter of competitive survival it is vital that your refining processes provide maximum quality to every gallon of gasoline produced.

Today's, and tomorrow's, increasing demand for higher octane fuels cannot be met by one high octane stream. No matter how good that one stream, there isn't enough of it to bring pool octanes up to required levels; and the higher you raise the quality of that stream the less you'll get.

This is why UOP has consistently devoted much of its research to the over-all development of more practical refining methods, the broad goal of helping you get the most out of every drop of oil that passes through your refinery.

An important result of this work is Universal's latest refining process—PENEX. This new process offers an efficient and practical method of up-grading pentane and hexane fractions, the previously neglected components that can so adversely affect the octane ratings of your pool gasoline.

In the race for higher octanes, you cannot afford to forget that the goal is to improve the general quality of your pool gasolines. PENEX offers a means of accomplishing this practically and economically. It should be given immediate consideration in your planning.

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILLINOIS, U. S. A.

Forty Years Of Leadership In Petroleum Refining Technology

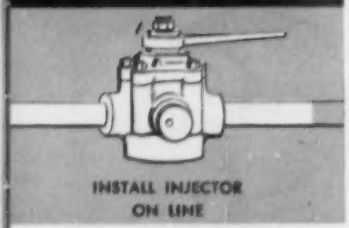
. . way back here

PENEX

TRADEMARK

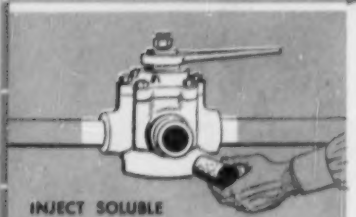
A new isomerization process for up-grading pentane and hexane fractions

KINNEY PLUG INJECTOR



INSTALL INJECTOR ON LINE

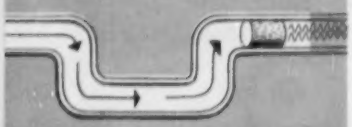
FLOW IS BY-PASSED — NO SHUTDOWN



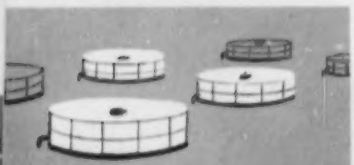
INJECT SOLUBLE PLUG IN INJECTOR

PRESSURE PUSHES PLUG

PLUG TURNS ALL BENDS IN PIPE



AND CLEANS PARAFFIN AS IT MOVES



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Removes Paraffin Without Shutting Down the Well . . .

KEEPS FLOW LINES OPEN

Hundreds of wells have already been equipped with Kinney Plug Injector on the flow lines. Made in sizes from 1″ to 4″ for low pressure and high pressure, the Kinney Plug Injector receives the soluble-mechanical plug by a simple turn of the handle which causes the flow to by-pass (see diagram to the left).

When plug is inserted and the handle turned in regular operating position, the plug is forced through the paraffin zone. The wax dislodged from the walls of the pipe by the moving plug is then carried out with the production oil. No shut-down time necessary, as a 1″ by-pass allows for equalized pressure to avoid damaging the plug.

The soluble-mechanical plug disintegrates within a few hours after injection, and need not be retrieved. The plug is designed to hold its hardness long enough to do the job and, at the same time, make all the necessary turns in the pipe in order to reach the destination. ***Oil Tool Sales Office—1404 Dunlavy—Houston 19, Texas; Oil Tool Warehouses in Beaumont and Odessa.***

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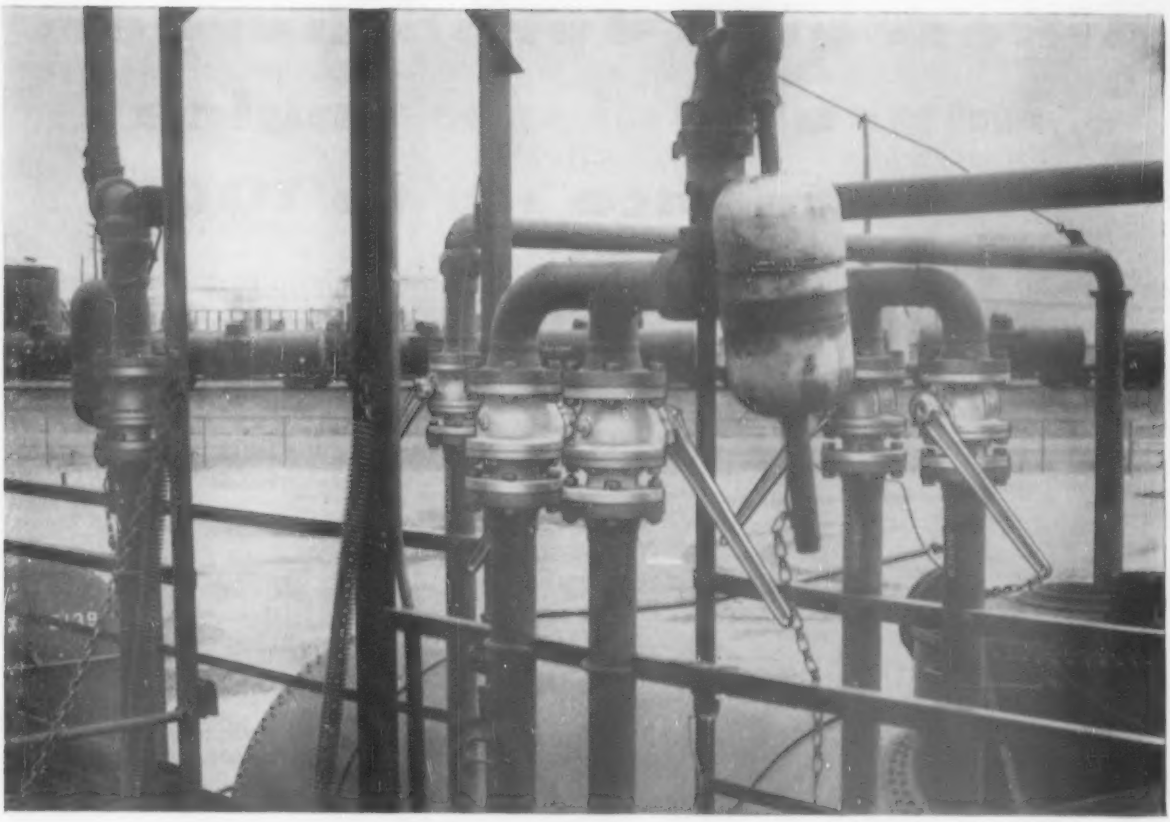

He said leaking couldn't be stopped

...*but Rockwood Ball Valves stopped it!*

The resident engineer of a major oil company was skeptical when we told him about the exclusive features of Rockwood Ball Valves. It was impossible, he said, to keep racks free from messy oil conditions due to drippings from valves. But he agreed to replace his old style valves with Rockwood Valves.

He was surprised at the result — *absolutely no leaking from Rockwood Ball Valves.*

It's easy to see why Rockwood Ball Valves are leakproof when you examine them. You'll find—

Full Round Pipe Size Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss.

Quick Opening and Closing — only a quarter turn needed.

Longer wear resistance — Chrome-plated bronze ball withstands abrasion, pitting and scratching.

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

It works as good as it reads! Send coupon today for complete information. Rockwood Ball Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.

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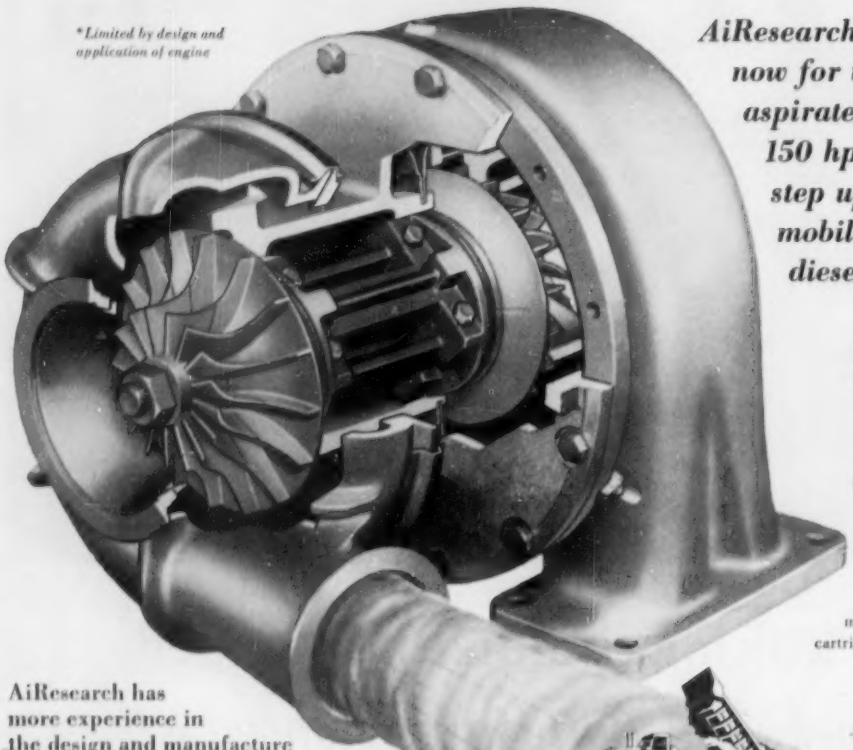

AiResearch units are available now for use with normally aspirated diesel engines of 150 hp and up. They step up performance of both mobile and stationary diesels, land or marine.

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AiResearch has more experience in the design and manufacture of small turbomachinery than any other company. AiResearch turbochargers are the most efficient and safest units of their kind. New additions to the AiResearch family of turbochargers have widened their range of application in the diesel engine industry.

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AIRESEARCH TURBOCHARGERS NOW AVAILABLE

MODEL	T-10	T-15	T-16	T-30
Diameter — in. nom.	9	15¼	11½	15¼
Length — in.	9	16¾	15¾	17¼
Weight — lb.	39	125	100	135
Output — lb/min. (Standard Conditions)	25-40	35-65	45-65	70-95

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They Say—

Collapse Predicted for U. S. Oil

"The great American oil industry, say the (European) economic diagnosticians, is on its last legs. The competition has become too great for high-cost and hard-to-find domestic crude. World economics, if given free play, has doomed it to an early grave.

"We suggest public and official consideration of these predictions in the fear that they may be proved correct unless, through awareness of them, positive action is taken to avoid this outcome by restricting excessive oil imports.

"What, according to the European prophets of gloom, is the U. S. picture?

"Drilling almost 90 per cent of all the wells drilled in the free world last year, we made a net addition to reserves of only 645 million barrels. . . .

"The net increase in Texas' proved reserves of crude oil and natural gas liquids last year, after deducting the year's production of just over 1 billion barrels, was a mere 69 million barrels.

"Considering crude oil only, Texas' reserves have actually fallen a little in 3 of the past 4 years. . . .

"U. S. production has never in the past for any sustained period exceeded an annual rate equivalent to more than 8 per cent of her proved reserves. . . .

"By 1965 on the same assumption, U. S. crude production could be raised only by a further 3 per cent or so to less than 7.5 million barrels per day.

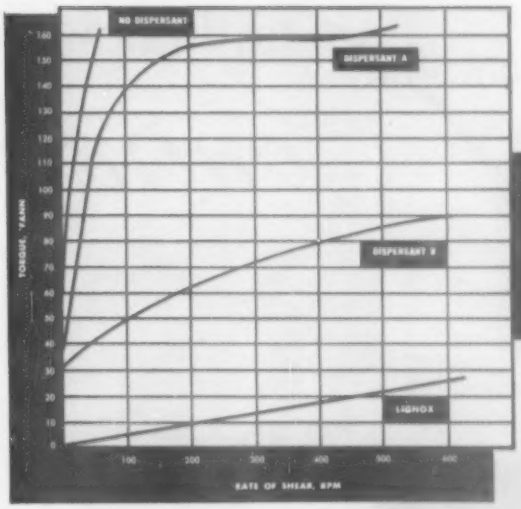
"The U. S. last year produced about 48 per cent of the free world's total output of crude oil from proved reserves representing perhaps as little as 10 per cent of the total."

Earl Turner, Texas Independent Producers and Royalty Owners Association, in statement before the Texas Railroad Commission, Austin.

There's Still a Chance

"A final solution of the woes of the producer . . . can come only through legislation by Congress. In his veto of the Harris bill, the President stated that he believed in the principles upon which the bill was based. Therefore, it would seem that in all fairness the President should take the initiative in obtaining remedial legislation.

"Efforts are being made within the industry—among producers on the one hand and the transmission lines and the local distributors on the other—to work out a satisfactory compromise. It is hoped that this can be done; and if this result is achieved, there is good reason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Inert, Non-Swelling Solids . . 60% by wt.
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The "mud" used to develop the curves shown here is not one you'd want to use for making hole. But in the laboratory it is one means of demonstrating how well LIGNOX disperses a mud system having a high calcium ion concentration — without the addition of caustic. And, of course, this dispersant performs equally well in low lime — low caustic drilling fluids and conventional lime base muds.

Furthermore, *LIGNOX muds are virtually unaffected by the contaminants encountered in normal drilling, e.g.: gypsum, anhydrite, cement, salt, lime, limey shales, and clay.

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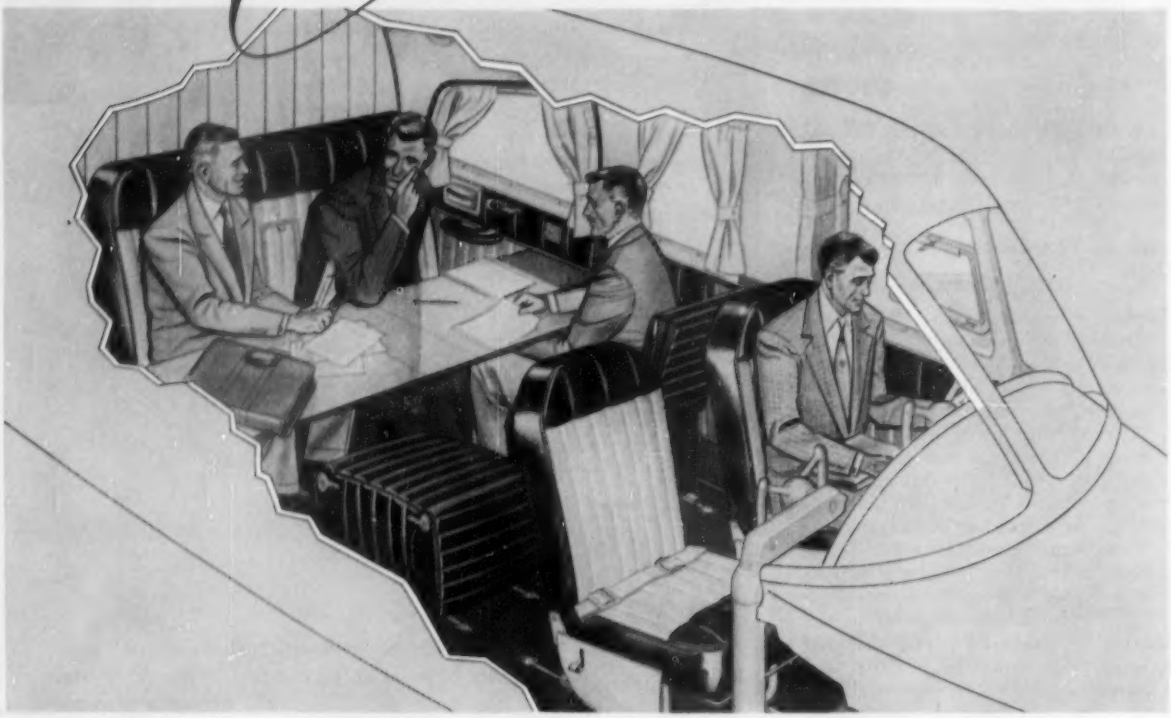
Commanders



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to hope that satisfactory legislation can be enacted. For the sake of the gas producers, consumers, our free enterprise system and our liberties, we should all work to this end."

Rex G. Baker, vice president and general counsel, Humble Oil & Refining Co., before annual convention of the National Oil Scouts and Landmen's Association, Corpus Christi, Tex.

Research = Profit = Research

"The chemical industry's research expenditure represents a greater proportion of its sales dollar than is the case in any other industry . . .

"Contrary to the popular opinion that 'dollar profit' motive will result in the stifling of creativity and individual talent, and the entire substitution of economics for science, the 'profit motive' can serve as a powerful stimulus and can produce invaluable rewards. The profit assures continuity of research. Profit can afford creativity and can reward it properly.

"For an industry which depends on research, profit has a two-fold aspect: it signifies (1) the financial return which must be produced; (2) the intellectual stimulation and sense of achievement which the individual must derive from his participation in the effort.

"If research is to be regarded as an instrument of sound progress rather than as a routine process attendant upon changes in economic climate, it is essential that the budget provide funds for this type of work and that management defend its aims."

J. J. Healy, Jr., assistant to the vice president in charge of research, development and engineering, Monsanto Chemical Co., before the seventh annual Conference on Industrial Research at Columbia University, New York.

The Most Efficient Method, Please

Dear Sir:

I have read with interest your article on our proposed water flood for the Pembina field, appearing in the June 11, 1956, issue of The Oil and Gas Journal.

I would like to call to your attention one misquote appearing in this article. You state: "Gas injection, Lewis reported, would recover only a small percentage more oil than a water flood . .", I believe this should read "Gas injection, Lewis reported, would recover only a small percentage of the recovery of a water flood." Your wording gives the connotation that gas injection gives greater oil recovery than a water flood and that for some unknown reason we have decided to use the less efficient pressure maintenance mechanism.

W. F. Allinder
Canadian Seaboard Oil Co.
Calgary, Alberta.

CALENDAR

JULY

18-20 Yellowstone-Bighorn Research Association, third Professional Short Course on Uranium Occurrence and Structural Geology, Red Lodge, Mont.

AUGUST

2-4 Rocky Mountain Mineral Law Foundation, Second Annual Institute, University of Colorado, Boulder.

20-21 North Dakota Oil and Gas Association, annual meeting, Bismarck, N. D.

27-29 Sixteenth Annual Gas Measurement Short Course, West Virginia University, Morgantown, W. Va.

SEPTEMBER

5-7 Wyoming Geological Association, eleventh annual field conference, Jackson Lake Lodge, Moran, Wyo.

9-12 Independent Natural Gas Association of America, annual membership meeting, St. Anthony Hotel, San Antonio, Tex.

11-13 Pacific Coast Gas Association, annual meeting, Coronado, Calif.

12-14 National Petroleum Association, annual meeting, Traymore Hotel, Atlantic City, N. J.

13-15 Chemical Institute of Canada, third Western Regional Conference, Edmonton, Alta.

16-18 New Mexico Petroleum Industries Committee, annual convention, Hilton Hotel, Albuquerque.

16-21 American Chemical Society, 130th

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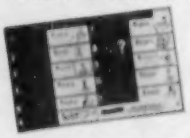

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R-P&C valves

annual meeting, Atlantic City, N. J.

16-21 American Society for Testing Materials, Second Pacific Area National Meeting, Statler Hotel, Los Angeles.

17-21 Instrument Society of America, eleventh annual international instrument-automation conference and exhibit, New Coliseum, New York City.

20-21 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo.

20-21 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, annual membership meeting, Roosevelt Hotel, New Orleans.

24-26 American Society of Mechanical Engineers, petroleum mechanical engineering conference, annual meeting, Statler-Hilton Hotel, Dallas.

26-28 Rocky Mountain Mineral conference, American Institute of Mining, Metallurgical & Petroleum Engineers, Newhouse Hotel, Salt Lake City.

OCTOBER

2-3 Texas Mid-Continent Oil and Gas Association, thirty-seventh annual meeting, Rice Hotel, Houston.

2-4 National Association of Corrosion Engineers, south central region, Beaumont.

7-9 American Association of Oil Well Drilling Contractors, annual meeting, Texas Hotel, Fort Worth.

11-12 California Natural Gasoline Association, fall meeting, Sheraton Hintington Hotel, Pasadena, Calif.

14-17 American Institute of Mining, Metallurgical & Petroleum Engineers, Petroleum Branch, fall meeting, Biltmore Hotel, Los Angeles.

14-20 OIL PROGRESS WEEK.

15-17 American Gas Association, annual meeting, Atlantic City, N. J.

18-19 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Rufus Garrett Hotel, El Dorado, Ark.

18-21 Permian Basin Oil Show, Odessa, Tex.

22-24 Rocky Mountain Oil and Gas Association, annual convention, Cosmopolitan Hotel, Denver.

29-30 Illinois Geological Survey, Petroleum Engineering Conference on Waterflooding, University of Illinois, Urbana, Ill.

29-Nov. 1 Society of Exploration Geophysicists, annual meeting, Roosevelt Hotel, New Orleans.

NOVEMBER

7-8 Philadelphia section, Instrument Society of America, Symposium on Process Data Logging, Stratford Hotel, Philadelphia.

8-9 American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Pacific Coast Joint Regional Meeting, Ambassador Hotel, Los Angeles.

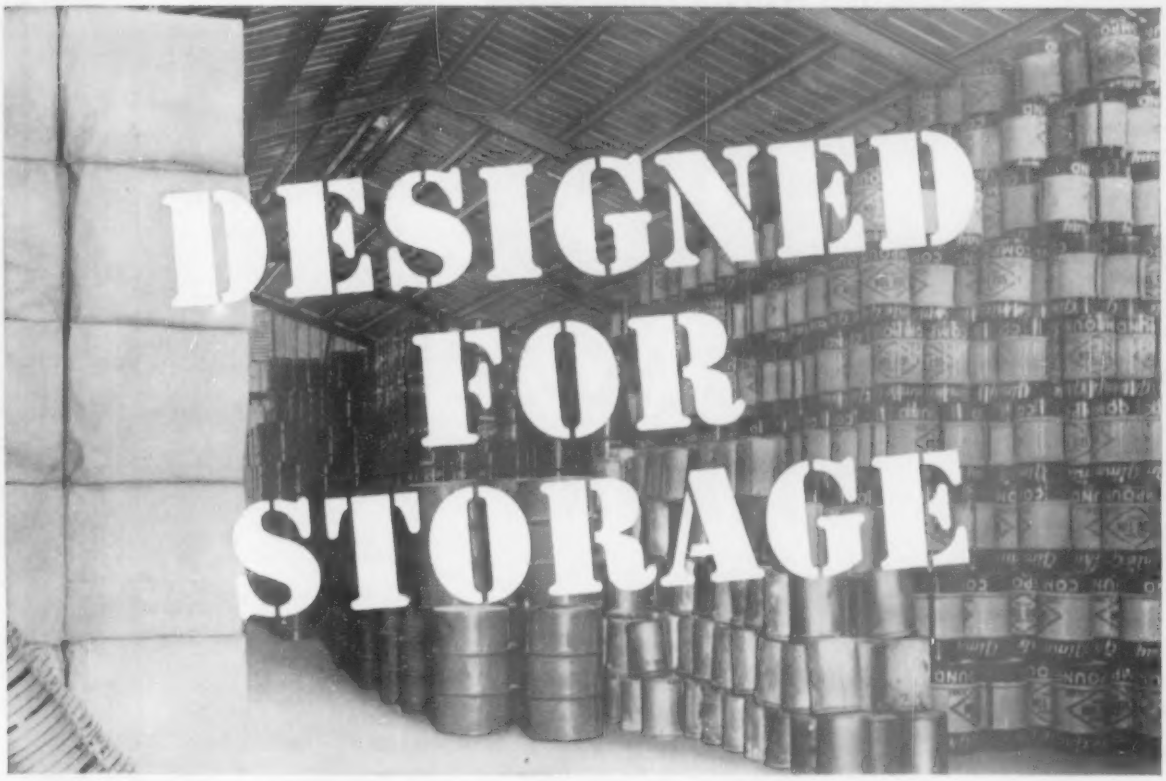
12-15 American Petroleum Institute, annual convention, Conrad Hilton Hotel, Chicago.

19-20 American Institute of Mining, Metallurgical & Petroleum Engineers, North Texas Secondary Recovery Symposium, Municipal Auditorium, Wichita Falls.

25-30 American Society of Mechanical Engineers, Statler Hotel, New York.

JANUARY (1957)

14-16 Pipe Line Contractors Association, ninth annual convention, Boca Raton Hotel and Club, Boca Raton, Fla.



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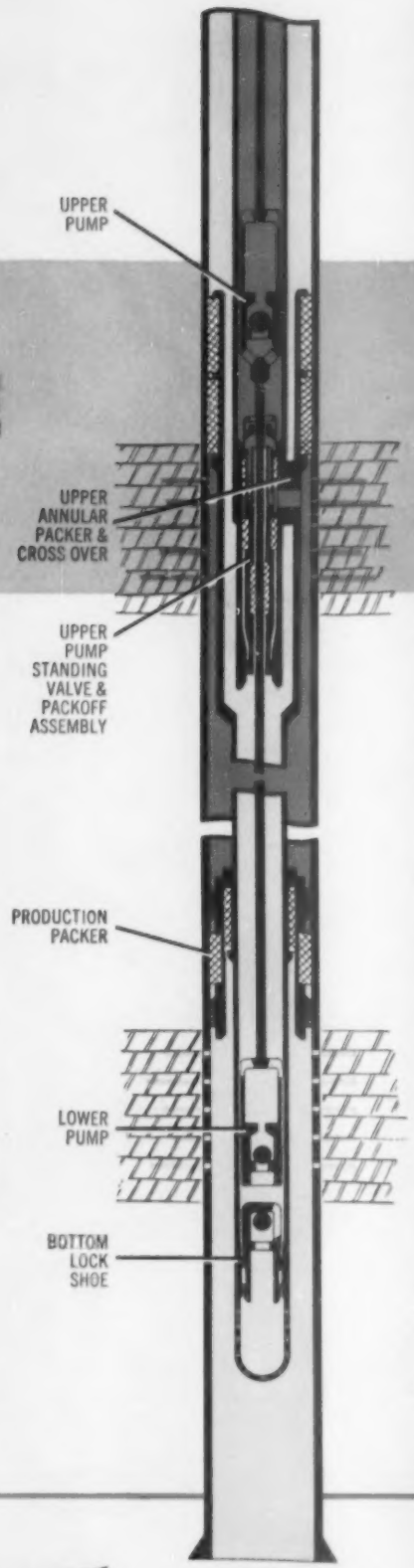

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without co-mingling the fluids

– backed by many years of research, development, field testing and experience. All sub-surface pumping equipment can be retrieved on the rod string. Production from either pay can be accurately controlled through the use of a pump overload valve.

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TULSA, OKLAHOMA

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JOURNALLY SPEAKING . . .

Alkygas—Again

WELL, we see by the papers that Congress is going to investigate the possibilities of unloading the farm surplus on the nation's motorists at the expense of the oil industry.

This may seem like a bright new idea to some folks, but actually it's at least 25 years old. It was a red-hot scheme back in the bottom of the Great Depression, and both farmers and oil men got all steamed up about it. In those days it was known as "alkygas."

Here's the plan: First you make alcohol out of corn. Nothing new about that, of course. It's a time-honored occupation. But instead of letting well enough alone at that point, the way they do in Kentucky, you mix this alcohol with gasoline. This transforms it from a fluid said to be good for internal consumption to one said to be good for internal combustion. Then you put this in the gasoline tank of your car and you get more mileage and less maintenance, more power and less ping than with just plain old gasoline. Or so they say.

Not only will the motorists benefit from this superior fuel, but so will the farmers. If only 10 per cent alcohol is blended with all the gasoline now being used in this country it will provide a brand-new market for about 2.5 billion bushels of corn every year. That will eventually make a dent in Uncle Sam's embarrassingly big holdings of surplus grain and bring joy to the heart of Iowa where the tall corn grows. A good deal all around. No wonder 34 farm-belt senators are backing the project.

There are just a few flies in the ointment. One is the fact that grain alcohol costs from 50 cents to $1.00 a gallon, depending on the price of corn. So a 10 per cent blend will make the motor fuel cost from 5 to 10 cents a gallon more than gasoline.

Not even the most enthusiastic alkygas boosters claim that the stuff is so much better that motorists will pay any such premium for it. However, they have a simple solution: Pass a law.

So far nobody has bothered to ask either the motorists or the oil companies what they think about having alkygas forced upon them. But that's of small moment. Votes can always be rallied for farm relief. Motorists are already paying taxes of 5 to 10 cents a gallon on gasoline, so another nickel or two will hardly be noticed. And the rich oil men should be glad to give up 10 per cent of their market to the farmers. Besides, it will conserve oil for the future and cut down the need for importing so much.

The law will have to have special provisions to keep oil companies from bootlegging. The danger is not that they will peddle the stuff in fifths to those who enjoy a short snort, but that they will make their own synthetic alcohol instead of using that made from grain. You see, perfectly good alcohol can be—and is being—made from natural gas at about half the cost of making it from corn. Something will have to be done about that if the farmers are to get the full benefit.

There seems to be little doubt that the use of some alcohol along with gasoline gives good motor performance. Only tests have shown that better results come from injecting it into the cylinders than by mixing it in the fuel tank. Several people have developed gadgets for doing this, but every time they get one perfected, the darned oil industry increases the octane ratings and other performance characteristics of gasoline so that the alcohol injectors are obsolete before they can be put into use. This is unfair competition with corn growers.

A number of foreign countries have required the use of alcohol - gasoline blends at various times in the past. In every instance they have been countries with little or no oil of their own, relatively few automobiles, and a shortage of foreign exchange to pay for imported fuel. The motors run on the blend all right, but the motorists can't afford to run them on it very much.

No, there's nothing new about alkygas. It climbs out of its grave and dances around in the moonbeams every time there is a big corn surplus. If this happens at a time when we also have a big oil shortage, the idea might get somewhere. Until that time comes —and the way things look now, it won't happen for quite a spell—we refuse to get excited about alkygas.

The fact that alkygas is getting a lot of attention in Washington at present simply proves that old ideas never die. In politics, as in TV, they just get a new sponsor.

Henry D. Ralph.

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How to determine who should burn gas

ONCE again the old bugaboo of "end-use control" of natural gas has been raised by the Federal Power Commission.

Because one commissioner reversed his position after a rehearing, FPC has backed away from end-use control in what promised to be a test case. It has decided that, on the basis of the particular facts in this case, the pipeline involved may sell a certain amount of gas to an electric company for boiler fuel.

But the issue of the "proper" uses of gas is still alive. It will become more active as the national argument over the price and supply of gas continues.

THE REASONING IS: Natural gas is in greater demand than most other fuels. Its ultimate supply may be less than the potential reserves of oil, and certainly less than coal.

Therefore, in the interests of conservation and wise use, gas should go only to its "superior" uses—uses for which it is particularly suited and which it can serve better than any other fuel. Gas should not go to "inferior" uses—such as industrial boiler fuel—which can be served just as well by coal or oil.

That makes considerable sense. The problem is how to do it.

ONE SOLUTION is to have FPC determine who should burn gas—and how much and where and under what conditions and at what price. To reserve supplies for residential, commercial, and specialized industrial uses it would deny gas to inferior uses where its chief attractiveness is low price in comparison with other fuels.

This would lead to arbitrary decisions, political influences, and jockeying among sellers of competing fuels. It would increase the supply for preferred users and thus keep the price down—for a while. But eventually a restricted market at a regulated price would discourage search for new supplies and there would be less gas and therefore higher prices.

ANOTHER SOLUTION is to let price and competition determine who burns gas. With no arbitrary controls, superior uses will pay more for gas than for less-suitable substitutes. The price of gas will rise to the point where inferior uses turn to other fuels. Competition and the individual business judgment of users will decide what is superior and what inferior. The question of end-use control will disappear.

The higher price of gas will encourage more conservation and stimulate search for new reserves. As supply increases, the price will come down. In the long run, preferred uses will get more total gas at less total cost.

In this way a free market will solve the problem of how to get more gas as well as the problem of who should burn it.

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The Industry This Week

Pipelines

• **Success of the first satellite compressor** station marks a new milestone in pipeline automation. Gulf Interstate's pioneer station indicates 10-15 per cent savings in operating costs, better control over line and delivery conditions, proven dependability and safety. Other stations are in the works. P. 66.

Big transportation savings may be in the cards for Middle East producers serving Europe. Royal Dutch-Shell and other companies are proposing a crude line from Marseille to Rotterdam. In addition to cutting tanker hauls from the Persian Gulf and Eastern Mediterranean ports, it also would enable refineries to be built near centers of consumption. P. 76.

L.P.G. and other products may be moving by pipeline from northern Alberta to the Lakehead area by the fall of 1957. Contracts have been let for an 800-mile products line from near Edmonton to Ft. William, Ont., by Canadian Hydrocarbons, Ltd. P. 74.

Production

• **A new secondary-recovery method** is about to be launched. Humble will inject rich casinghead gas in two zones of Texas' Bronte field. Humble claims technique will recover 50 per cent more oil from the two pays than water flooding. P. 70.

Operators expect to parlay a $1,000,000 water flood in North Midland Farms field in West Texas into a $31,000,000 recovery of crude. P. 68.

Industry

• **Another big growth year** has been rolled up by L.P.G. underground storage. Capacity has reached 22.2 million barrels, 40 per cent above a year ago, according to a Journal survey. No expansion letup is in sight before '59. P. 58.

Half interest in Trinidad Petroleum is being sought by Colorado Oil & Gas. The Colorado Interstate subsidiary wants to buy stock from British Controlled Oil Fields, which owns 50 per cent of Trinidad Petroleum. P. 82.

Continental has joined the superpremium parade. Conoco is selling "Royal Super" in 24 stations in the Houston area. The company has declined to reveal the rating of the fuel, but it is believed to be near 100. P. 71.

Exploration

• **Successful bidders for high-priced Venezuelan lake tracts,** the second group offered in a month, may be disclosed this week. Bids were received Friday on six national-reserve blocks totaling 43,000 acres. They're expected to bring more than $1,000 an acre. P. 62.

Helicopters were the backbone of a wildcat operation in a remote New Guinea area. Use of the whirlybirds for the first time to haul in drilling equipment, erect a rig, and maintain and supply the operation has aroused interest of operators as well as manufacturers. P. 80.

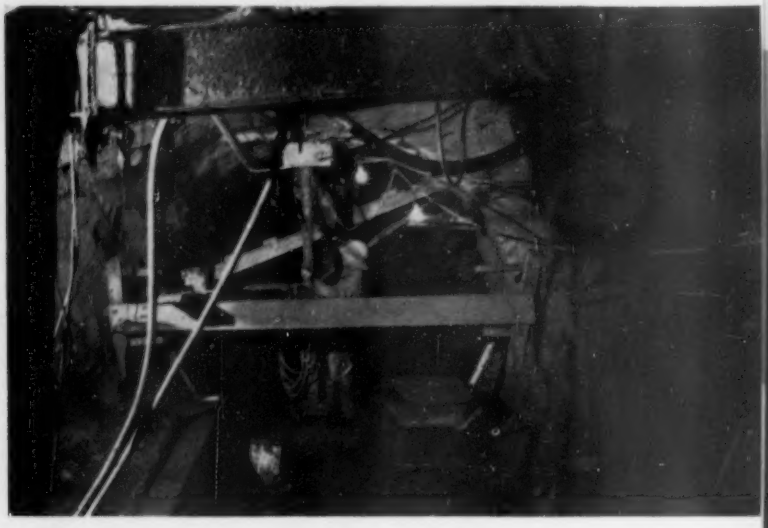
Processing

• **Cities Service may close** its 53,000-bbl. East Chicago refinery. The plant has been shut down by a strike 3½ months. Company officials say the strike, which stemmed from wage disputes, is delaying long-range planning. Workers are represented by a union affiliated with O.C.A.W. P. 65.

What could develop into a petrochemical center is in the making at Sarnia. Imperial plans a petrochemical plant at Sarnia to produce basic feedstocks for other plants. Imperial also is buying land around the plant site in hopes of selling the land to firms that will buy its plant's output. P. 69.

← **Engineers check one of Sohio's two 30,000 bbl. storage caverns at Lima.**

↓ **Tunnels are heavily reinforced**



Two more boom years seen as . . .

. . . L.P.G. Storage Keeps Growing

Gene T. Kinney

UNDERGROUND storage, which helped raise L.P.G. from a stepchild to a full-grown industry in its own right, has rolled up another banner growth year.

The rate of gain was nothing like the previous year when storage rose 73 per cent, but still must be considered "booming" by any standards. Producers and marketers continued to take a big fancy to this relatively new type of storage, which provides cheap waiting room for L.P.G. during the off season when stocks are built up to meet peak winter demands.

Underground storage capacity increased 40 per cent to more than 22,000,000 bbl., according to a survey by The Oil and Gas Journal. The percentage gain was only a little more than half that of a year ago. But the increase was almost as much.

New capacities added by companies reporting to the Journal totaled 6,300,000 bbl. compared with 6,900,000 bbl. listed in the last survey *(The Oil and Gas Journal, August 1, 1955, page 60).*

Storage now available is sufficient to hold 16 per cent of all L.P.G. sold during 1955. And at least one more big year is in the offing and probably more. Eighteen new projects now under way or planned, plus expansions of existing caverns, will raise capacity another 8,400,000 bbl.

The Journal survey lists 217 projects operated by 51 companies in 14 states. Caverns washed out of salt layers and domes, by far the cheapest underground storage, account for 17,375,000 bbl., or 78 per cent of the total. Mined rock totals 1,168,000 bbl., or 5 per cent, and oil and gas sands, 3,652,000 bbl., or 17 per cent.

Storage continues to be concentrated in the producing areas of the Southwest and Gulf Coast, although it is spreading slowly into the southeast, northeast, and upper Midwest.

Texas leads way . . . Texas, with 53 per cent of the nation's L.P.G. production, increased its share of total storage to 71 per cent.

Texas' capacity shot up 50 per cent to 15,765,000 bbl., about equal to the national total a year ago. Its dominant position is shown by the fact that the second-ranking state, Mississippi, has just over a million barrels. And only one other state, Kansas, is in the million-barrel category, although Louisiana will cross that mark next year.

New caverns . . . Texas Butadiene & Chemical Corp. is completing five wells with capacity exceeding a million barrels in the Barbers Hill salt dome at Mont Belview, Tex.

Ultimate capacity may be two or three times as great, the company said. Butane and isobutane will be moved out of storage through two 14-mile pipelines to the company's butadiene and avgas plant which is going up near Channelview, Tex. L.P.G. will be delivered to storage by transport truck, tank car, and pipeline.

Tennessee Gas Transmission Co. also will wash out caverns in the same salt dome to store 1,250,000 bbl. The product will be piped 200 miles to the affiliated Petro-Tex Chemical Corp. butadiene plant at Banquete, Tex.

Phillips Petroleum Co. has completed part of a project in the Clemens salt dome near its Sweeny, Tex., refinery which may eventually hold 1,000,000 bbl. of butane and ethylene. Ethylene will be piped to plants of Phillips and other companies on the Houston Ship Channel.

New storage ideas . . . The industry got its first storage cavity ever mined in chalk this year.

Built by Tuloma Gas Products Co., subsidiary of Standard Oil Co. (Ind.), and Sinclair Oil & Gas Co., it is located in Marengo County near De-

Who's Storing L.P.G. Underground, Where, and How Much

ALABAMA

Company and county—Type of storage—	Capacity in bbl. Present	Ultimate	Product
Tuloma Gas Products Co.-Sinclair Oil & Gas Co.:			
Marengo—Mined chalk	140,000	140,000	Butane
Marengo—Mined chalk		200,000	Propane

CALIFORNIA

Los Angeles—Water sand	150,000	150,000	Propane
Los Angeles—Water sand	150,000	150,000	Butane
Los Angeles—Water sand	100,000	100,000	Propylene

ILLINOIS

National Petro-Chemicals Corp.:			
Douglas—Mined shale	170,000	170,000	Propane
Phillips Petroleum Co.:			
Kankakee—Mined shale	260,000	260,000	Propane
Warren Petroleum Corp.:			
Kane—Mined shale	50,000	50,000	L.P.G.
White—Mined shale	50,000	50,000	L.P.G.

KANSAS

Cities Service Oil Co.:			
Reno—Salt layer	50,000	50,000	Butane
Reno—Salt layer	50,000	50,000	Butane
Reno—Salt layer	50,000	50,000	Propane
Reno—Salt layer	50,000	50,000	Propane
Reno—Salt layer	50,000	50,000	Propane
Reno—Salt layer	50,000	50,000	Propane
Reno—Salt layer	66,000	75,000	Propane
Reno—Salt layer	66,000	75,000	Propane
National Cooperative Refinery Association:			
McPherson—Salt layer	45,000	50,000	Propane
McPherson—Salt layer	45,000	50,000	Propane
McPherson—Salt layer	45,000	45,000	Butane
McPherson—Salt layer	45,000	45,000	Butane
McPherson—Salt layer	32,000	45,000	Butane
McPherson—Salt layer	5,000	45,000	Butane
Phillips Petroleum Co.:			
Kingman—Salt layer (three caverns)	225,000	300,000	Propane, butane
Skelly Oil Co.:			
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	30,000	30,000	Propane
McPherson—Salt layer	340	30,000	Propane
McPherson—Salt layer	100	30,000	Propane
McPherson—Salt layer	100	30,000	Propane
McPherson—Salt layer	150	30,000	Propane
McPherson—Salt layer	800	30,000	Propane
Stanolind Oil & Gas Co.:			
Grant—Salt layer	27,000	27,000	Butane
Grant—Salt layer	25,000	25,000	Propane
Grant—Salt layer	26,000	26,000	Propane
Grant—Salt layer	25,000	25,000	Butane
Grant—Salt layer	25,000	25,000	Butane
Grant—Salt layer	25,000	25,000*	Propane

LOUISIANA

Esso Standard Oil Co.:			
Ascension—Salt dome		150,000	Butane
Ascension—Salt dome		150,000	Butane
Ascension—Salt dome		150,000	Propane
General Gas Corp.:			
Bienville—Salt dome	100,000	200,000	B-P mix
Bienville—Salt dome	100,000	200,000	Propane
Bienville—Salt dome	84,000	100,000	Butane
Bienville—Salt dome	84,000	100,000	B-P mix
Bienville—Salt dome		476,000	L.P.G.
Gulf Oil Corp.:			
St. Landry—Salt dome	138,000	200,000	Propane
Petroleum Sales, Inc.:			
Evangeline—Salt dome	100,000	100,000	B-P mix
Evangeline—Salt dome	100,000	100,000	B-P mix
Evangeline—Salt dome	75,000	100,000	Propane
Warren Petroleum Corp.:			
Bienville—Salt dome	130,000		L.P.G.
Bienville—Salt dome	70,000		L.P.G.

MICHIGAN

Cities Service Oil Co.:			
Kent—Salt layer	100,000	100,000	Propane
Kent—Salt layer	40,000	100,000	Propane
Skelly Oil Co.:			
Kent—Salt layer	87,000	100,000	Propane
Sun Oil Co.:			
Wayne—Salt layer	90,000		Propane
Wayne—Salt layer	135,000		Butane

MISSISSIPPI

Anchor Petroleum Co.:			
Forrest—Salt dome	190,000	250,000	Propane
Forrest—Salt dome	190,000	250,000	B-P mix
Forrest—Salt dome	190,000	250,000	Propane
General Gas Corp.:			
Forrest—Salt dome	24,000	100,000	B-P mix
Forrest—Salt dome	36,000	100,000	Propane
Skelly Oil Co.:			
Forrest—Salt dome	110,000	120,000	Propane
Forrest—Salt dome	50,000	50,000	Butane
Warren Petroleum Corp.:			
Forrest—Salt dome	200,000		L.P.G.
Forrest—Salt dome	200,000		L.P.G.
Forrest—Salt dome	200,000		L.P.G.

MISSOURI

Missouri Hydro Gas Co.:*			
Greene—Mined limestone	25,000	25,000	B-P mix

NEW MEXICO

Atlantic Refining Co.:			
Lea—Salt layer		50,000	Propane
Lea—Salt layer		50,000	Butane
El Paso Natural Gas Co.:			
Lea—Salt layer	50,000	50,000	L.P.G.
Lea—Salt layer	39,000	50,000	L.P.G.
Gulf Oil Corp.:			
Lea—Salt layer	56,000	60,000	L.P.G.
Lea—Salt layer	30,000	50,000	Butane
Sacra Bros.:			
Eddy—Salt layer	12,000	36,000	Propane
Eddy—Salt layer	36,000	36,000	Propane
Eddy—Salt layer		30,000	L.P.G.
Skelly Oil Co.:			
Lea—Salt layer	70,000	100,000	Propane
Lea—Salt layer	40,000	50,000	Propane
Lea—Salt layer	80,000	100,000	Butane
Warren Petroleum Corp.:			
Lea—Salt layer	80,000		L.P.G.
Lea—Salt layer	43,000		L.P.G.

NEW JERSEY

Esso Standard Oil Co.:			
Union—Mined cavern		300,000	Propane

NEW YORK

Anchor Petroleum Co.:			
Steuben—Salt layer	100,000	175,000	Propane
Steuben—Salt layer	100,000	175,000	Propane
Steuben—Salt layer	50,000	175,000	Propane
Steuben—Salt layer	40,000	175,000	Propane
Suburban Propane Gas Corp.:			
Cortland—Salt layer	150,000	200,000	Propane

OHIO

Standard Oil Co. (Ohio):			
Allen—Mined shale		30,000	Propane
Allen—Mined shale		30,000	Propane

OKLAHOMA

Carter Oil Co.:			
Pontotoc—Abd. oil wells	173,000		L.P.G.
Shell Oil Co.:			
Beckham—Salt layer	15,000	15,000	Propane
Sinclair Oil & Gas Co.:			
Seminole—Mined shale	110,000	110,000	Propane

TEXAS

Anchor Petroleum Co.:			
Martin—Salt layer	60,000	80,000	Propane
Martin—Salt layer	60,000	80,000	Propane
Martin—Salt layer	60,000	80,000	Propane
Martin—Salt layer	60,000	80,000	Butane

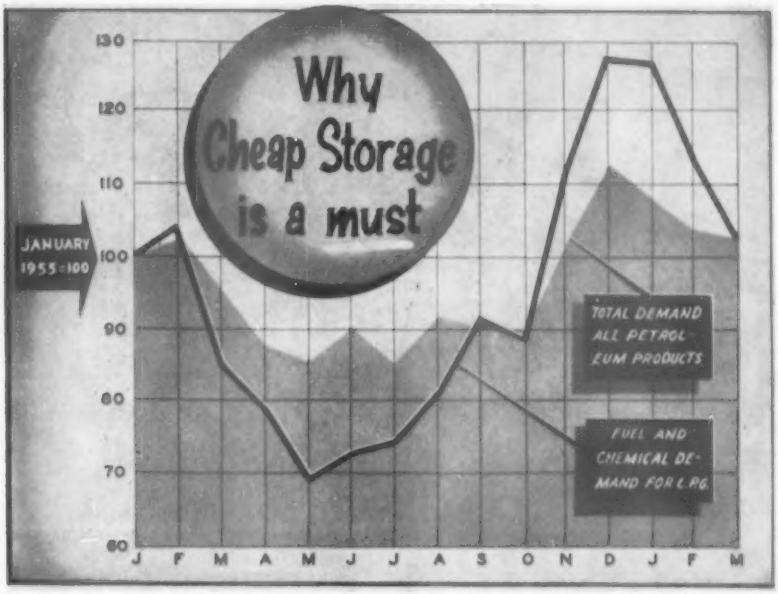
TEXAS (Continued)

Company and county—Type of storage—	Capacity in bbl. Present	Capacity in bbl. Ultimate	Product
Martin—Salt layer	55,000	80,000	Butane
Martin—Salt layer	55,000	80,000	Butane
Cities Service Oil Co.:			
Gray—Salt layer	86,000	86,000	Propane
Gray—Salt layer	86,000	86,000	Propane
Continental Oil Co.:			
Reagan—Salt layer	38,000	50,000	Propane
Cosden Petroleum Corp.:			
Howard—Salt layer	50,000	50,000	Butane
Dorchester Corp.:			
Carson—Salt layer	55,000	60,000	Propane
Carson—Salt layer	35,000	40,000	Butane
Dow Chemical Co.:*			
Brazoria—Salt dome	100,000	100,000	Propane
Brazoria—Salt dome	200,000	200,000	Propane
Ellis Transport Corp.:*			
Harris—Salt well	200,000	200,000	Butane
Harris—Salt well	200,000	200,000	Propane
El Paso Natural Gas Co.:			
Reagan—Salt layer	148,000	150,000	L.P.G.
Reagan—Salt layer	165,000	165,000	L.P.G.
Reagan—Salt layer	75,000	150,000	L.P.G.
Reagan—Salt layer	131,000	150,000	L.P.G.
Reagan—Salt layer	135,000	150,000	L.P.G.
Reagan—Salt layer	104,000	150,000	L.P.G.
Reagan—Salt layer	94,000	150,000	L.P.G.
Reagan—Salt layer	66,000	150,000	L.P.G.
Reagan—Salt layer	77,000	150,000	L.P.G.
Reagan—Salt layer	134,000	150,000	L.P.G.
Enterprise Petroleum Gas Co.:*			
Wood—Salt dome	50,000	50,000	B-P mix
Wood—Salt dome	50,000	50,000	Propane
Freestone Underground Storage Corp.:			
Freestone—Salt dome	75,000	75,000	Propane
Freestone—Salt dome	50,000	50,000	B-P mix
Gulf Oil Corp.:			
Crane—Salt layer	45,000	50,000	Propane
Crane—Salt layer	28,000	50,000	Butane
Jefferson—Salt dome	150,000	150,000	Ethylene
Jefferson—Salt dome	160,000	160,000	Propane
Jefferson—Salt dome	210,000	210,000	Butane
Jefferson—Salt dome	94,000	150,000	Ethylene
Humble Oil & Refining Co.:			
Waller—gas sand	500,000		Butane
Waller—gas sand	1,000,000		Propane-ethane mix
La Gloria Corp.:			
Jim Wells—Sand	72,000	72,000	Butane
Jim Wells—Sand	72,000	72,000	Propane
Lion Oil Co. (as operator):			
Scurry—Salt layer	138,000	150,000	Propane
Scurry—Salt layer	132,000	150,000	Propane
Scurry—Salt layer	120,000	150,000	Propane
Scurry—Salt layer	124,000	150,000	Butane
Llano Grande Corp.:			
Cochran—Salt layer		50,000	L.P.G.
Cochran—Salt layer		50,000	L.P.G.
Magnolia Petroleum Co.:			
Jim Wells—Sand	150,000	150,000	Propane
Liberty—Salt dome	800,000	1,200,000	Butane & propane
Pecos Co.:			
Midland—Salt layer	50,000	50,000	L.P.G.
Midland—Salt layer	50,000	50,000	L.P.G.
Midland—Salt layer	50,000	50,000	L.P.G.
Midland—Salt layer	50,000	50,000	L.P.G.
Phillips Petroleum Co.:			
Brazoria—Salt dome (three caverns)	160,000	600,000	Propane, butane, ethylene
Hutchinson—Salt layer (10 caverns)	991,000	1,375,000	Propane, butane, isobutane
Pure Oil Co.:			
Andrews—Salt layer	100,000	112,500	Propane
Andrews—Salt layer	100,000	112,500	Propane
Reef Fields Gasoline Corp.:			
Howard—Salt layer	47,000	47,000	Propane
Howard—Salt layer	57,000	57,000	Propane
Howard—Salt layer	43,000	43,000	Propane
Howard—Salt layer	39,000	39,000	Propane
Howard—Salt layer	43,000	43,000	Butane

TEXAS (Continued)

Company and county—Type of storage—	Capacity in bbl. Present	Capacity in bbl. Ultimate	Product
Howard—Salt layer	38,000	43,000	Butane
Sid Richardson Gasoline Co.:			
Winkler—Salt water sand			Butane & propane
Winkler—Salt layer	144,000		Propane
Winkler—Salt layer	96,000		Butane
Winkler—Salt layer	60,000		Propane
Shamrock Oil & Gas Corp.:			
Moore—Oil sand	1,200,000		B-P mix
Shell Oil Co.:			
Yoakum—Salt layer	180,000	180,000	Propane
Yoakum—Salt layer	170,000	170,000	Propane
Skelly Oil Co.:			
Carson—Salt layer	120,000	120,000	Propane
Carson—Salt layer	57,000	75,000	Propane
Carson—Salt layer	35,000	50,000	Propane
Carson—Salt layer	86,000	100,000	Butane
Carson—Salt layer	62,000	75,000	Butane
Southern Minerals Corp.:			
Nueces—Oil sand	85,000	85,000	B-P mix
Standard Oil Co. of Texas:			
Scurry—Salt layer	21,000	21,000	Propane
Scurry—Salt layer	35,000	35,000	Propane
Scurry—Salt layer	25,000	25,000	Propane
Scurry—Salt layer		25,000	Propane
Stanolind Oil & Gas Co.:			
Andrews—Salt layer	50,000	50,000	Propane
Andrews—Salt layer	50,000	50,000	Butane
Andrews—Salt layer	50,000	50,000	Propane
Ector—Salt layer	125,000	150,000	Propane
Hockley—Salt layer	50,000	50,000	Propane
Hockley—Salt layer	67,000	100,000	Propane
Sun Oil Co.:			
Jefferson—Salt dome		100,000	Butane
Sunray Mid-Continent Oil Co.:			
Scurry—Salt layer	33,000	35,000	Propane
Scurry—Salt layer	32,000	35,000	Propane
Scurry—Salt layer	28,000	30,000	Propane
Scurry—Salt layer	54,000	55,000	Butane
Scurry—Salt layer	32,000	35,000	Butane
Tennessee Gas Transmission Co.:			
Chambers—Salt dome		1,250,000	Butane & propane
Texas Butadiene & Chemical Corp.:			
Chambers—Salt dome (five caverns)	1,000,000	2,000,000	Butane
The Texas Co.:			
Hardin—Salt layer	110,000	110,000	Butane
Hardin—Salt layer	110,000	110,000	Butane
Hardin—Salt layer	110,000	110,000	Butane
Hardin—Salt layer	170,000	170,000	Butane
Scurry—Salt layer	55,000	55,000	Propane
Texas Natural Gasoline Corp.:			
Chambers	250,000	250,000	Butane
Chambers	250,000	250,000	Propane
Chambers	300,000	300,000	Butane
Chambers	75,000	200,000	Butane
Glasscock—Salt layer	100,000	150,000	Butane
Harris—Salt well	250,000	250,000	Butane
Harris—Salt well	250,000	250,000	Propane
Upton—Salt layer	188,000	200,000	Propane
Upton—Salt layer	120,000	150,000	Propane
Upton—Salt layer	85,000	150,000	Propane
Upton—Salt layer	75,000	150,000	Propane
Upton—Salt layer	100,000	150,000	Butane
Upton—Salt layer	90,000	150,000	Butane
Upton—Salt layer	100,000	150,000	Butane
Warren Petroleum Corp.:			
Stephens—Mined shale	25,000		B-P mix
Stephens—Mined shale	38,000		B-P mix
Smith—Salt dome	175,000		L.P.G.
Smith—Salt dome	225,000		L.P.G.
Smith—Salt dome	200,000		L.P.G.
VIRGINIA			
Bottled Gas Corp. of Virginia:			
Nelson—Abd. railway tunnel		95,000	Propane
WISCONSIN			
United Petroleum Gas Co.:			
Pierce—Mined sandstone			Propane
Total	†22,195,490	‡30,594,000	

*1954 figures. †Does not include projects where capacity is not reported. ‡Includes present capacity when ultimate capacity is not shown.



mopolis, Ala., and is the first underground L.P.G. storage for the state.

The Selma chalk in which the cavern was mined fills all the requirements for good storage. It is pure, eliminating the danger of contamination, and strong enough so that pillars left after excavation will support the roof. It has very low permeability, promising product recovery of almost 100 per cent.

Conventional mining methods used were the same as for shale or other rock formations. The main shaft was drilled to 320 ft. and 42-in. casing set. Lateral tunnels 12 to 16 ft. wide and 28 ft. in height were blasted out of the chalk. Supporting columns, 30 to 40 ft. in diameter, were left in a staggered pattern.

One unique aspect of construction was the use of a 7-ton bulldozer, lowered down the 42-in. casing piece by piece, to remove chalk from the tunnels *(The Oil and Gas Journal, June 21, page 86)*.

Construction costs . . . Since construction was similar to other mined rock caverns, the per-barrel costs would be the same.

They would amount to $5 to $7. That compares with $1 to $2 for salt storage and $20 for steel tanks.

Chalk is widely distributed and offers prospects for storage in other areas where it is found close to the surface.

Two other pioneer projects are being watched closely. Bottled Gas Corp. of Virginia is converting a railroad tunnel in Virginia. It is still in the testing stage. Pilot work has been completed for a Wisconsin cavern mined in sandstone by United Petroleum Gas Co. The permeable sandstone will be coated with a synthetic-rubber sealant. The company expects to have a commercially usable reservoir within the next year. Some engineers are skeptical of its ability to hold the stored product, so outcome will be watched closely.

Storage uses . . . Besides simply holding off-season production until the heavy-demand season and permitting marketers to obtain supplies at summer prices, storage has other functions.

Some facilities are little more than conservation projects. If storage is cheap and handy—such as abandoned oil or gas wells—L.P.G. may be pumped down the hole to avoid flaring. Whatever is recovered is just that much the operator would not have had otherwise.

Refiners, large users of L.P.G. for blending, have various uses for storage. Standard Oil Co. of California operates three storage wells in a water sand at its El Segundo refinery. They provide operating flexibility when units which make or use L.P.G. are off.

Storage no cure-all . . . While underground storage—a strapping youngster only 6 years old—has not solved the L.P.G. industry's problems by any means, the industry certainly could not have grown so big so fast without it.

It is now enjoying the most stable period in its history. The usual price drop when demand slows in the spring did not come this year. The winter price of 4½ cents per gallon still holds at midsummer. Marketers are confident the price will remain firm.

The main reason for confidence is low inventories. The industry came out of last winter with storage so low that it is doubtful whether caverns can be filled by the start of next season. A year ago the situation was reversed.

The Bureau of Mines reported that the October 31, 1955, storage total of 387 million gallons had been lowered to 114 million gallons by March 31. The net withdrawal of 273 million gallons was almost double the previous winter's reduction.

But current healthy conditions cannot be attributed to underground storage, although it helps. There was plenty of storage for the 1954-55 season. Yet the price broke in January, right in the middle of the heating season. The difference was the weather.

A late winter left sales in the doldrums during 1954-55 and marketers, afraid of entering the spring with storage still full, panicked and dropped the price to 2 cents per gallon. That was just half the early winter price and the lowest since L.P.G. became a major petroleum product.

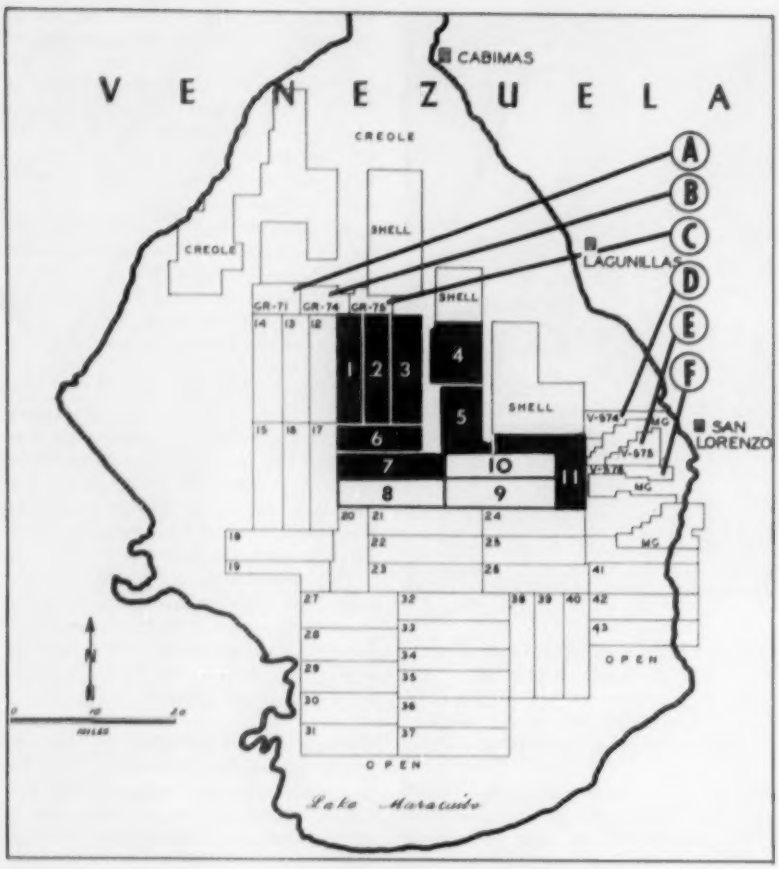
Last winter was severe and the price held. The problem was getting enough product to areas of high demand, particularly the southeast. More storage near these spots would have prevented a transportation crisis.

Outlook . . . The more the industry grows, the wider become the gaps between the peaks and valleys of demand. L.P.G. fluctuates twice as much as the demand for all petroleum products (see chart).

More storage in consuming areas would help offset this fact. And the prospect is for gradual growth along this line. But it still would not be the final answer. Too much storage outside producing areas might leave marketers vulnerable to the vagaries of the weather. Mild weather in a spot where considerable product was on hand would depress the price and perhaps force its movement elsewhere, doubling transportation costs. One solution is storage at the gateway to a big area which would not commit product to a single market.

More valuable than underground storage would be large individual consumer storage. A customer going into the winter with half his heating requirements would need but a single refill.

Plans of the major L.P.G. producers and marketers point to probably 2 more big years of storage expansion in the Southwest and Gulf Coast. Some companies have too little storage for smooth operations, but others are finding it difficult to justify outlays for more capacity. The industry total is approaching what is considered to be a proper relation to demand and a leveling off appears to be in order soon. Then storage expansion will more nearly parallel actual growth of the industry itself.



What's on the Map

New Tracts Offered

A, B, C—7,700 acres.
D—12,263 acres.
E—12,066 acres.
F—9,985 acres.

Who Got First Tracts

1—Sun-Atlantic.
2—Mene Grande.
3—Mene Grande.
4—Sohio-Signal-Pure-Hancock.
5—Creole.
6—Mene Grande.
7—Shell.
8, 9, 10—Not yet awarded.
11—Mene Grande*.
*Another report gives Mene Grande No. 10 and lists 11 as not yet awarded.

To Be Offered

12-43—These tracts, drawn up on basis of exploratory interest, are good candidates for later offering.

After first new leasing in 11 years . . .

. . . Venezuela Opens National Reserves

VENEZUELA may reveal this week the identity of successful bidders on more than 43,000 acres of national reserve lands beneath the waters of oil-rich Lake Maracaibo.

Bids on the six new tracts were received July 13 in the latest of a series of moves to open new lake acreage to oil exploration. The government was expected to make an announcement about the successful bids within 48 hours after receiving company offers.

Venezuelan representatives here in the United States predicted the quick announcement regarding the latest acreage offered. But there still had been no official word late last week on the nearly $200 million offered by nine oil companies for open lake acreage more than a month ago *(The Oil and Gas Journal, June 11, page 100 and July 2, page 77)*.

The Journal has learned from informed but unofficial sources in Venezuela which tracts the successful June bidders won (see map). Bidders themselves, like the government, are still keeping quiet. It is understood that President Marcos Perez Jimenez wants to make the announcement later.

The most recent action in putting national reserve lands on the block for the first time in more than 11 years was heralded by an announcement by the president. The official gazette set July 13 as a deadline for the new bids and spelled out the conditions attached to the bidding. There was no public statement about the earlier sale.

The different handling was dictated by the fact that tracts up for bid this time were national reserves. They must be advertised under the law.

More than 35,000 acres put on the block last week is off the eastern shore of Lake Maracaibo and completely surrounds lands held by Mene Grande Oil Co. (Gulf).

Another 7,700 acres is in the north-central region of the lake adjoining acreage held by Creole Petroleum Co. (Jersey Standard) and Cia. Shell de Venezuela. It is bounded on the south by two of the 10,000-hectare blocks offered for bids June 9.

The offered national reserve acreage in the area where Mene Grande now has lake holdings is in five separate blocks. In the national reserve block numbered V-574, there are two tracts, one of 10,185 acres and the other of 2,078 acres. Immediately to the south of this in Block V-575, are two more separate tracts, one of 10,697 acres and the other of 1,969 acres. In the third block, V-576, there is a single tract of 9,985 acres.

The acreage is considered semi-proved. The national reserves, turned back to the government when concession holders converted to exploitation, for the most part directly offset production. These blocks are among the most attractive in Venezuela.

Here are the conditions set forth by the president's announcement:

. . . **An initial bonus** of $600 per acre. This is 25 per cent higher than the

minimum bid which the government set on the acreage offered June 9. Bids could be double the minimum.

. . . An exploitation tax of one-sixth of all oil produced to be credited to the government.

. . . Concession holders must refine in Venezuela at least 15 per cent of all crude produced. Up to now this figure has been 10 per cent.

. . . No flaring of natural gas. Companies will be compelled to cooperate with the government in establishing a national network of natural-gas pipelines to conserve the gas produced. The government claims one-sixth of the gas produced.

. . . An additional 8 per cent production tax will be charged against all crude produced that is refined outside Venezuela but in the Caribbean area.

Europeans may compete . . . The government announcement admitted frankly that it expected keen competition between the "Big Three" (Creole, Shell, and Mene Grande) and other American and European companies.

The Big Three now produce about 1,300,000 bbl. daily in the lake. Mene Grande certainly will be in the bidding for the acreage which virtually surrounds its lake holdings.

Some observers in this country thought it was significant that the government specifically mentioned European companies along with other American companies in connection with the competition. The June 9 bidding added five American companies to the Venezuelan roster. All of them are new to the country. They are Signal Oil & Gas Co., Hancock Oil Co., Sohio Petroleum Co., Pure Oil Co., and Sun Oil Co.

Sun and Atlantic Refining Co., which already has Venezuelan holdings, were the successful bidders on a 10,000-hectare block just to the south of one of those offered last week. A new four-company combine of Signal, Hancock, Sohio, and Pure made what has been the top bid of more than $1,100 an acre for another 10,000-hectare block offered last month.

According to all unofficial reports Creole and Shell each offered top bids for a block and Mene Grande got four. The three remaining blocks of the original 11 tracts offered were not sold and early this month the government asked for new bids on those three *(The Oil and Gas Journal, July 9, 1956).*

Next offerings . . . Selling the high-priced lake tracts will bring the government the quick money it was after.

But these limited sales will not permit half the interested companies to enter the world's second-largest producing country. Neither will they broaden the production base as much as Venezuela would like, and it is unlikely that they will result in finding the high-gravity oil which is desired.

But the end to the 11-year holiday on new concessions offers hopeful companies encouragement that these first two sales are just the beginning. There are 32 more lake tracts which are regarded as top candidates. The government mapped them on the basis of interest shown by companies doing preliminary exploration.

The opening of national reserves last week was regarded as a sign that similar acreage in eastern Venezuela might be the next to go on the auction block.

Is Trans-Canada "snake bit"?

. . . Steel Strike Another Hurdle

CALGARY.—First it was politics, then financial woes. Now the steel strike.

"The most snake-bitten project in the world," a Calgary oil man described it. He was talking about Trans-Canada pipeline, stunned by the steel strike in the United States just after its loan victory in Parliament cleared the way for construction to start.

The strike is already a threat to the plans of Trans-Canada Pipe Lines, Ltd., which must complete the 574-mile Alberta-Winnipeg section this year under terms of the government loan. A prolonged walkout would knock it out this year for sure, handing another setback to the project which has been fighting for 5 years to get under way.

When the mills closed June 30 only 120 miles of 34-in. pipe—one-fifth of the requirement for the western leg—had been rolled at three United States mills. Some still has not been shipped.

And, according to company officials, there is no clause in the loan bill or permits with the government covering delays caused by material shortage. If, however, the strike should prevent Trans-Canada's reaching Winnipeg by the deadline, it would provide a good argument for an extension.

As the contract now stands the company must forfeit its assets in the line to the Canadian Government if the deadline is not met.

Trans-Canada's deal with the pipe producers was that pipe would roll from the mills as required up until November.

Only two spreads working . . . Only four of the seven spreads have been contracted and announced, and only two are working.

Majestic Contractors, Ltd., Edmonton, and Canadian Bechtel, Ltd., Toronto, are busy clearing right-of-way and grading in preparation to start excavation and pipe laying next week. Their spreads are the first two, starting at the Birstall, Sask., western terminus at the Alberta border, and extending to a point east of Moose Jaw. They cover about 110 miles each.

The other two contractors are Manix, Ltd., and Dutton-Williams Brothers, Ltd., both of Calgary. They were to have started work around July 15.

Ninety days has been mentioned as sufficient time for actual pipe laying. Each spread can lay about a mile a day. On that basis, if more pipe were available in sufficient quantity by September 1, the line could still be completed by December 31. The project, which envisions export to the United States, is eventually to extend to Montreal, making it the longest in the world at 2,250 miles.

Process Improved

Ceramic balls better than steel in retorting oil shale

DENVER.—Scientists at the University of Denver's Research Institute have made a major improvement in the Swedish Aspeco process of flameless retorting of shale oil.

Under the process originated by Aspegren & Co. of Stockholm, oil shale is tumbled in a ball mill with steel balls heated to 1,000°. This drives off the oil as vapors. The balls are reheated and fed through the mill continuously. There is no contamination of the oil by flames or smoke.

The research institute has replaced the steel balls with ceramic balls as a result of research conducted by project manager Dr. Thomas Nevins, aided by John Hobaugh, Werner Schnackenberg, and Robert Fisher.

Dr. Nevins said the ceramic balls last longer, carry more heat, and are cheaper.

Studies with the small "flameless cooker" are resulting in design improvements for a 24-ton-a-day pilot plant soon to be built south of Denver for the institute by Stearns-Roger Manufacturing Co. at a cost of more than $100,000.

The research institute's work is being performed under a $250,000 contract signed earlier this year with Oil Shale Corp. of Beverly Hills, Calif., for development of the Swedish process.

ODM Looks to Canada

Flemming admits defense planning is pegged to Canadian crude moving to West Coast to meet any wartime demand

WASHINGTON. — Defense planners are placing increasing reliance on Canadian oil to meet any wartime lack of domestic supply on the Pacific Coast.

This was made clear last week by Mobilization Director Arthur S. Flemming. He told a House armed services subcommittee that civil production, plus imports through the Trans-Mountain pipeline, will be "more than adequate" to meet military requirements in the area.

The subcommittee is studying the West Coast's wartime supply position and the need for a West Texas-California crude line for which the West Coast Pipe Line Co. for several years has been trying to secure a certificate of essentiality.

Last week, Flemming told the subcommittee that nothing has occurred during the past year to change the view that "the West Coast pipeline—although sufficiently related to national defense to justify the issuance of a rapid tax-amortization certificate—is not essential to meet wartime requirements."

Guaranty declined . . . West Coast is asking that the Government provide a guarantee for the line based on the difference between its average daily throughput and a 75,000-bbl. estimated "breakeven" load.

Flemming pointed out that, in addition to West Coast production and imports through the Trans-Mountain pipeline, the Southern Pacific products line from El Paso to Los Angeles could be used to transport crude from Texas for emergency use in southern California.

District 5 has another supply advantage. Its imports are not included in the Cabinet fuels committee's formula, which applies to imports from areas other than Canada and Venezuela.

Production peak reached . . . Flemming explained this is based on the fact that production in the district is "about as high as it can be," taking account of resources currently available there. It was also concluded that the present rate of imports into the area will not discourage exploration and discovery.

If imports into District 5 reach a point where they would discourage exploration and discovery, importers will be asked to reduce their entries, Flemming said.

Inability to fill West Coast requirements of aviation gasoline and residual fuels will make it necessary for the military to bring supplies in from both the gulf states and the Persian Gulf, Capt. C. C. Drescher, chief of the Armed Services Petroleum Purchasing Agency, testified.

California shortage denied . . . California interests refused to agree with Drescher that there was a shortage in the area, however.

T. S. Petersen, president of Standard Oil Co. (Calif.), asserted the ASPPA generally will have no serious problem in obtaining supplies.

The aviation-gasoline shortage is not confined to the West Coast and is not related to crude supplies, he said, but is related to alkylation capacity and refinery operations to meet other requirements.

The residual fuel situation, tight in the first quarter because of exports to the East Coast and other markets and a colder-than-normal winter, is improving, Petersen said.

Even if the shortage of products is not corrected, he continued, a change in the source of supply of crude will not result in additional volume.

"Under such conditions only a substantial increase in the fuel-oil price will set the economic forces in motion that will ultimately increase the volume available," Petersen declared.

He outlined the additional refinery capacity building on the West Coast and the additions to crude resources expected to be made available by the opening of offshore development in California.

If these developments do not meet the situation, it is possible a pipeline may be necessary, he admitted. But it will be several years before that will be shown, he said.

Four Corners crude . . . Increased natural gas receipts and a possible new oil province in the Four Corners area of Arizona, Utah, Colorado, and New Mexico may go far to round out the West Coast picture, he pointed out.

The Four Corners area is within 600 miles of Pacific tidewater. Geologists estimate that some 50,000 bbl. daily or more may be developed within a reasonable length of time.

Petersen suggested that the best way to meet a possible emergency would be to stockpile materials for the quick building of a line if needed for defense. He concluded:

"We have not and will not oppose the building of a pipeline by private interests with private financing, and believe the line will be built as soon as it is sufficiently justified economically to obtain such financing. To date, this situation has not developed."

Canadian L.P.G. Line Develops

WINNIPEG.—Pipe has been ordered and contracts let for an 800-mile products pipeline from Alberta to Lake Superior.

The 6 and 8-in. line, to carry L.P.G., natural gasoline, and other products, will be built by Canadian Hydrocarbons, Ltd. *(The Oil and Gas Journal, March 5, page 61).*

The Canadian Parliament has approved a permit for the $60-million project. Detailed plans are being prepared for presentation before the Federal Board of Transport Commissioners and the Alberta Petroleum and Natural Gas Conservation Board.

W. F. Davey, president of Canadian Hydrocarbons, said construction will be carried out by Hydrocarbon Pipelines, Ltd., a subsidiary. Williams Brothers, Calgary, and A. D. Little & Co., Boston, will be consultants.

It will be the first major pipeline of its kind in Canada. Work is to begin in the early spring and completion is scheduled during the fall. Purpose of the line, Davey said, is to make the products available to rural areas and link refineries and processing plants. Manitoba officials said the line would lead to construction of a $20-million ammonia fertilizer plant at Winnipeg. The plant is planned by Winnipeg & Central Gas Co., Ltd.

Canadian Hydrocarbons plans to ship L.P.G. and other products by tanker across the Great Lakes to eastern Canada. Canada produces a negligible amount of L.P.G. and natural gasoline now. But the volume will rise sharply with the completion of field plants which will process gas going into the Trans-Canada and Westcoast pipelines.

The route of the line has not been definitely decided, nor has the originating point. But it's expected to run from the Edmonton area to Ft. William, Ont., on Lake Superior. One proposed route is through Saskatoon,

Sask., Minnedosa and Brandon, Man., to Winnipeg and Ft. William.

Questions raised . . . In Alberta, however, the project raises many questions.

The chief one is: Will the Alberta Government change its announced policy of holding back on permits to export hydrocarbons as a move to bring industries to the province?

The government recently announced a set of regulations governing export of butane, ethane, and propane. Persons or companies who export must register with the conservation board and make monthly reports. Premier Manning announced at the last sitting of the legislature that a closer check would be kept on movements of gas.

The new Gas Resources Preservation Act covers export by means other than pipeline. Pipeline removal of natural gas, already requiring a permit, is interpreted as including ethane, propane, and butane.

Refinery May Close

Permanent closing of East Chicago plant considered

CHICAGO.—Cities Service Oil Co. may abandon its 53,000-bbl. East Chicago, Ind., refinery if the strike-bound plant isn't operating by July 20.

W. T. Cravens, vice president in charge of refining, told the refinery's 525 employes in a letter last week that all provisions of the company's final offer of a settlement would be withdrawn if operations have not been resumed by then.

The final offer was submitted by Cities Service on June 22, but has not been voted on by the union, an affiliate of the Oil Chemical and Atomic Workers Union.

In Bartlesville, Okla., Cities Service officials said the permanent closing of the refinery is a possibility if the strike does not end soon. Even if it is not, negotiations to end the strike will revert on July 20 to their status when the strike started, they said.

The 3½-month shutdown stemmed from problems other than wages. Cities Service offered to settle on the basis of the national pattern of a 6 per cent or 15 cents an hour wage increase. The union, however, insisted on contract provisions covering grievances previously handled through arbitration.

The company said it would be "reluctant" to permanently close the refinery. Without a settlement at East Chicago, however, "long-range planning" must be started, and these plans would cover the possibility of a withdrawal from the Chicago area, they said.

watching WASHINGTON

. . . with Bertram F. Linz

Annual clearance rush on in congress . . .

THE annual rush to wind up the congressional session has started at the Capitol.

Committees are going through the bills before them, tossing out everything of less than major importance. But a lot of less-vital bills have been sent to the House and Senate floor, where they, too, will be winnowed. Several measures in which the oil industry has an interest are due to be scrapped in the process.

There hasn't been much in the way of oil legislation passed this year. The big one was the Harris gas bill, doomed by presidential veto. But there has been a lot of talk about oil, and a substantial number of bills on the subject were filed. Some of these will set the stage for action next year.

Coming: A look at the future . . .

A NEW study of the long-range prospects in oil requirements and the impact of present government policies on the fuel industries is due to be finished sometime in the next few months.

The study is being made by Resources for the Future, Inc., which is carrying on the work started by the Paley materials policy commission. The Paley group made a series of reports to the White House in 1952 on energy and material needs up to 1975. It then disbanded.

The resourses survey will cover the expected growth of the economy over the next 25 years or more. Special attention will be given to those changes in industries and sectors which will most affect the demand for fuel and power.

This will include study of the likely cost-trends in oil and other fuels as they are affected by changes in available resources and advances in their production, transportation, and use.

Another angle will be the effect of policies and acts of the federal and state governments on operations in the energy industries. These have been developed piecemeal over a long period of time. As a result, their total impact on the oil and other industries has never been clearly defined.

All this will be topped by an attempt to figure out the part to be played in the energy picture by atomic and other new sources 25 years hence.

The report, which may be issued next winter, is planned as the basis of a long-run research program going deeply into existing public policies and pointing the way for their improvement.

A study of government policies may cover the Natural Gas Act as well as public-land development and other phases of the Government's relation to the oil and gas industry.

Equipment industry gages trends in oil . . .

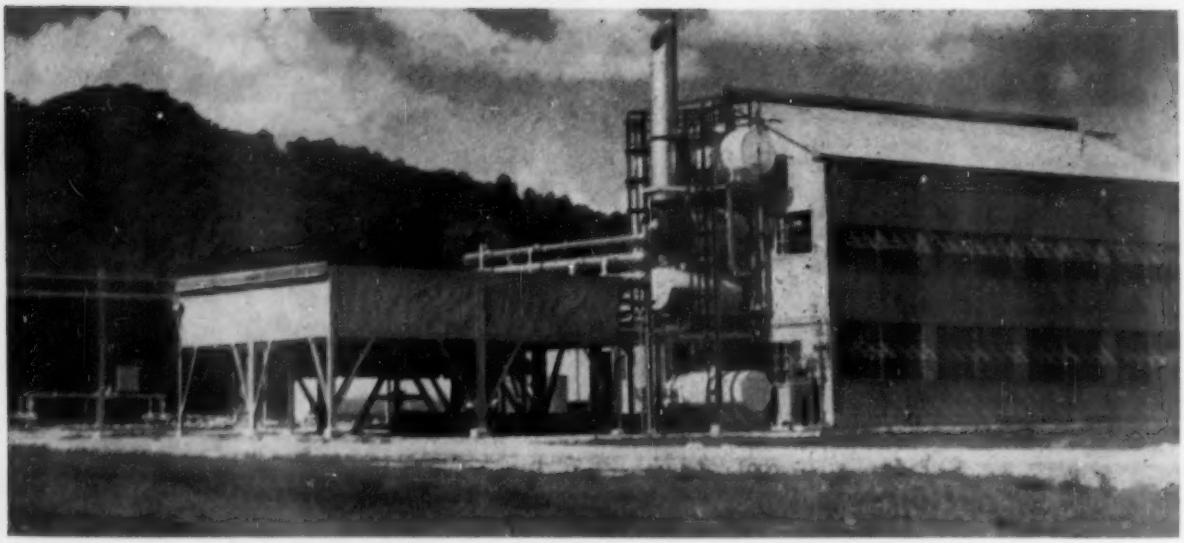
THE making of oil-field equipment is a half-billion dollar industry and growing fast.

The Census Bureau reported last week that 1954 shipments had a value of $513,400,000. That was a neat 78 per cent increase over 1947, when shipments were worth $288,900,000.

The figures on equipment tell the story of the oil industry, its expansion and trends.

Expansion is shown in the figures on drilling equipment. Shipments rose from $147,489,000 in 1947 to $282,500,000 in 1954.

It's no news that the trend in drilling is toward the rotary. But how far it has gone is shown by the census report. The output of cable drilling equipment has shrunk from around 9 to less than 5 per cent of the total output. It dropped from $16,390,000 in 1947 to $11,353,000 in 1953, while shipments of rotary equipment increased from $121,782,000 to $225,326,000.



LOOK, NO HANDS! That's the situation at Stanton station, the first of its kind.

In pipeline compressor stations . . .

. . . Automation Proves a Success

STANTON, Ky.—Success of the first satellite compressor station is another important milestone on the road to pipeline automation.

The prototype station, located near here, has been operated remotely by Gulf Interstate Gas Co. without a hitch since March 27. The results convinced the FPC that the station should be made a permanent part of the company's 1,160-mile system from the Gulf Coast to West Virginia.

A company announcement indicates it is planning to build or convert other stations. More robot stations were understood to be in the works, anticipating the successful trial run and FPC approval. And other companies can be expected to follow suit before too long.

The enthusiasm for the robot station is explained by the results of the first few months' operation:

. . . **Savings in operating costs** estimated at 10 to 15 per cent.

. . . **Better control** over line and delivery conditions.

. . . **Proven dependability** and safety.

The same principles of control that permit the station to function, the company said, also are applicable to multi-engine stations that may be built at the present intermediate locations on the system. Further improvements and refinements of the first station were predicted. But the company added:

". . . The basic design will definitely establish the pattern for Gulf Interstate Gas Co. expansions."

Built at a cost of $730,000, the station had 15 months in which to prove itself under the FPC certificate. Within a year the company reported remote operation was both feasible and economic *(The Oil and Gas Journal, June 18, page 134)*. Operating information is telemetered to Clementsville, Ky., 80 miles away. The operator there has push-button control over the station.

The engine has suffered no false shutdowns that have not been caused by man. Minor repairs or adjustments have taken only 9½ hours of down time since March 27.

Robot Station Timetable

November 1954—Design started.

January 10, 1955—Application filed with FPC.

April 29, 1955—Robot station authorized by FPC on experimental basis.

June 15, 1955—Construction contract awarded.

July 12, 1955—Construction begun.

December 21, 1955—Local operation of station started.

March 27, 1956—Remote operation begun.

May 21, 1956—Day operator dropped.

June 5, 1956—4 p.m. to 12 midnight shift discontinued.

June 16, 1956—Midnight to 8 a.m. shift discontinued, leaving station unattended with FPC authority to make it a permanent part of Gulf Interstate system.

Evolution of idea . . . Existing stations on the line are 8,000 hp., operated semiautomatically with but a single operator per shift on each of the five stations. Gulf Interstate describes their operation since the November 1, 1954, start as unusually good.

At this time the question of remote operation was largely academic and was viewed in many quarters with open skepticism. But the semiautomatic stations had scarcely been started up when the satellite began to take shape in the minds of Gulf Interstate engineers. They wanted to experiment and develop a guide for major building programs of the future.

Here was the chance they were looking for. They were attracted by these prospects:

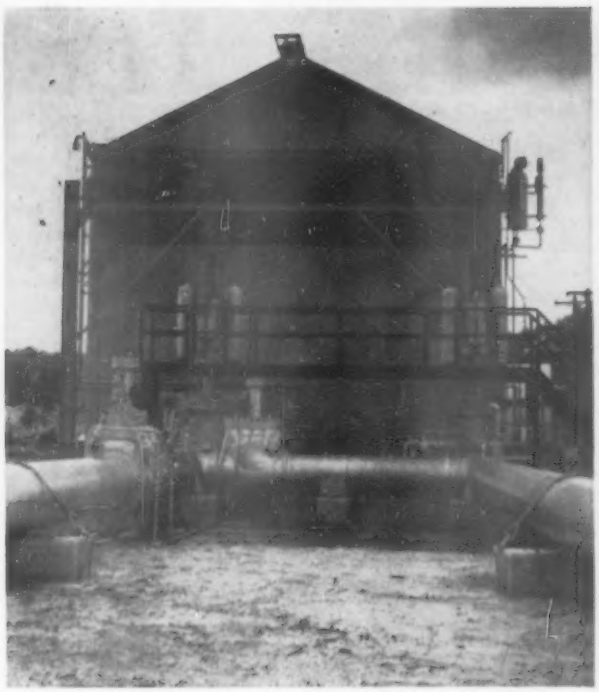
. . . **Labor-saving operations** of existing stations pointed to the feasibility of remote control, making possible still more savings.

. . . **Greater flexibility** in delivery pressures could be attained to handle peak demand periods.

. . . **If automatic operation didn't** work, the station design would permit easy conversion to a permanent installation using one man per shift.

. . . **If the FPC refused** a permanent certificate and automatic features weren't practical, most equipment could be used in a conventional station.

Equipment design . . . In determining the stations, engineers were guided by



MAIN ENGINE BUILDING, showing suction line, right, and discharge line, left. Centrifugal compressor is in the center of the photograph.

CONTROLS for the Stanton station are in the main engine room at Clementsville. Operator here adjusts the discharge-pressure recorder.

one idea. Unattended operation had to be achieved safely and reliably at a cost below conventional operation.

An engine-driven centrifugal power unit was chosen over angle reciprocating and gas-turbine centrifugal on the basis of operating-cost, fuel-cost, and thermal-efficiency studies.

Cooper-Bessemer Corp. was selected to build the 16-cylinder, 4-cycle LSV reciprocating engine driving a centrifugal compressor. It is rated at 3,500 hp. The engine is spark-ignited, supercharged, and utilizes turbocooling on a manifold intake air. This permits increased horsepower delivery without a high heat load on the engine. The engine consumes 6,000 B.t.u. of fuel per brake horsepower hour. Jacket water is coil-cooled by a single fan driven off the main engine through a fluid drive coupling with an automatic governor controlling fan shaft speed.

Between the engine and compressor is a speed increaser manufactured by Western Gear Works. It increases r.p.m. from 360 at the engine to 5,500 into the compressor. The engine and gear train are located inside the main engine building. The vertical centrifugal compressor is on a block outside and adjacent to the main engine building.

Peak engine capacity is more than 500,000 M.c.f. per day at a discharge pressure of 935 psi. At a rate of 375,000 M.c.f. per day, with the engine operating at 327 r.p.m.-3,500 hp., the compressor achieves an 83 per cent efficiency factor. Mechanical loss through the compressor is 1 per cent and through the gear train 2.5 per cent.

The controls, manufactured by Union Switch & Signal Co., have two functions:

. . . **Normal operational control** from the remote point. The Clementsville operator pushes a button to start the engine, set the discharge pressure control, and stop the engine remotely.

. . . **Automatic shutdown or alarm** sequences. There are 52 automatic safety controls falling into three categories: alarm, shutdown-restart, and shutdown-lock out.

Remote operation . . . With the discharge pressure controller in position, the operator presses the start button.

The startup sequence begins if all controls are in position and working. The compressor is purged and the engine starting circuit is energized. If auxiliary equipment is working, the main engine starts.

The engine idles, then rapidly accelerates through a critical speed range. The compressor case is brought to line pressure and the discharge and suction loading gate valves are opened. The engine, partially loaded, is warmed up. The discharge pressure is raised to the discharge controller setting and the unit is fully loaded and on the line.

All this is done automatically from controls put in motion 80 miles away.

Pressing another button closes the main fuel gas valve, safety fuel valve, the line suction and discharge valves, cuts off the ignition system, and opens the blowdown valve, venting the compressor.

Safety devices . . . The many safety controls take into account every conceivable emergency.

. . . **Automatic shutdown** occurs until the trouble is corrected if there is: a break in the pipeline, low-suction pressure, fire in the main or supervisory building, excessive vibrating in the compressor, engine, gear, piping or fan, or if there is low remote-control shutdown air pressure.

. . . **Engine shuts down** immediately, with permissive restarts, if controls detect engine overspeed or low readings in engine oil pressure, gas oil pressure, turbo oil pressure, compressor oil pressure, seal oil level, seal oil drain level, gear oil temperature, or engine oil temperature.

It shuts down also when there is high discharge pressure, gear oil pressure, engine oil pressure, engine oil temperature, gear oil temperature, discharge gas temperature, thrust bearing temperature, compressor case temperature, starting air temperature, or jacket water temperature.

Texas Floods Planned

Unit expects to recover $31,000,000 worth of additional crude with $1,000,000 project in North Midland Farms field

AUSTIN. — A proposed $1,000,000 water flood of the Grayburg pay in North Midland Farms field in West Texas is expected to recover an added 12,300,000 bbl. of oil—about $31,000,000 worth at present prices.

These attractive economics were laid before the Texas Railroad Commission here last week by Stanolind Oil & Gas Co., operator of a proposed unit for the Andrews County field.

The $1,000,000 investment includes estimated initial and operating costs.

The unit would include 2,640 acres and 40 producing wells. All working and royalty interests have signed an agreement. It calls for sharing oil recovery on a formula based 100 per cent on gross acre-feet of pay.

The field is located on a north-south trending anticline and produces from the Grayburg at about 4,750 ft. It was discovered in July 1953 and is now producing about 1,700 bbl. daily. Total production to March 1 was 1,239,00 bbl.

The natural drive is primarily solution gas. This has shown up in sharply dropping reservoir pressure. Bottomhole pressure originally was 1,768 psi. By the first of this year, it had plunged to only 976 psi.

The proposed unit wants to convert six wells around the field perimeter to injection services and to inject the water below the original oil-water contact.

The injection supply would be brackish water from the Santa Rosa formation and produced water from the Grayburg.

Other operators participating in the unit are: Magnolia Petroleum Co., Southern Production Co., Sharples Oil Corp., Forest Oil Corp., Anderson-Prichard Oil Corp., and David and Inez G. Fasken.

Other floods sought . . . Plans for a cooperative flood of the Colby sand were submitted to the commission by operators in Keystone (Colby sand) field of Winkler County, West Texas.

And two large separately operated projects were unveiled for Loma Novia field in South Texas, Duval County, by Humble Oil & Refining Co. and The Texas Co.

The Keystone field flood will recover an estimated 3,337,000 bbl. of oil over that possible by primary production.

It will be a cooperative effort by Skelly Oil Co., The Texas Co., Tidewater Oil Co., General American Oil Co. of Texas, Stanolind, and J. Bashara Sons Prothro Co.

The project will take in about 2,100 productive acres and require 40 input wells for the planned 40-acre, five-spot injection pattern. Sixteen will be converted producers; the rest drilled.

The Colby in Keystone is a dolomite sandstone anticline topped at 3,170 ft. It was discovered in February 1930, and production now is in the late stage of depletion with some wells in the stripper stage. Average daily per well output is 4 bbl.

Water for the flood will come from the 1,000-ft. Rustler salt-water zone. It will be injected initially at a rate of 900 to 1,000 bbl. a day per input well under less than 1,000 psi.

Loma Novia floods . . . The Texas Co.'s Loma Novia sand flood in the field of the same name will take in about 685 of the field's 7,500 acres.

The leases have 40 wells producing an average of about 7½ bbl. daily each. Texaco says wells have about reached the abandonment stage under primary production.

The company will convert 32 producers to input service and drill 7 more injection wells to complete a five-spot flood.

Humble plans to flood about 390 acres with 13 wells on a similar flood plan. It will convert two wells to input service and drill several more. The company expects to recover an added 725,000 bbl. of the 6,248,000 bbl. estimated as originally in place.

Strike to Delay Gilsonite Plant

NEW YORK — American Gilsonite Co. hopes to be producing high-purity, electrolytic coke for the metallurgical industry and 86-octane unleaded gasoline from a unique solid hydrocarbon by next spring.

American Gilsonite had planned to have its plant in operation by the fall of 1956 *(The Oil and Gas Journal, July 11, 1955, page 90)*. Completion date for the plant has now been set up to April 1, 1957, with the good possibility that it will actually go on stream nearer June 1.

E. F. Goodner, president of the company owned jointly by Barber Oil Co. and Standard Oil Co. of California, conceded last week the steel strike may delay completion of the plant at Gilsonite, Colo., near Grand Junction. He said steel plate for the process units has already "been set aside in the fabricating plants," but added that any possible government priorities for steel could easily upset schedules.

Goodner said his company has already selected the contractor for the 70-mile, 6-in. pipeline linking the processing plant with Utah mining operations. But, he said, the contract has not actually been let because the steel strike has clouded the picture.

Unique operation . . . The plant now being constructed claims a number of "firsts."

It will process gilsonite (uintaite) through delayed cokers to produce an unusually high-grade coke. A byproduct of the coker will be 1,300 bbl. daily of gasoline. The overhead from the coker will be fractionated and the gasoline fraction fed to a two-stage U.O.P. catalytic reformer (Platformer) to produce the gasoline.

On a charge of 630 tons of gilsonite per day the plant is expected to produce 1,300 bbl. daily of 86-octane gasoline, 300 bbl. of fuel oil, and 250 tons daily of calcined coke.

Aside from the novel process units—claimed as the first to make petroleum products from a solid hydrocarbon—the company has instituted novel mining and transportation features in its operation.

Gilsonite is a black, solid hydrocarbon with a high resin content that has been mined near Bonanza, Utah, since 1904. It occurs in nearly vertical fissures in the earth that vary in depth from 100 ft. to 2,000 ft. and up to 22 ft. in width. Principal veins of the material are in the Unitah basin of eastern Utah and western Colorado.

The processing plant was built in Colorado rather than the Utah mining area because the former offers railroad facilities and a suitable market for the gasoline byproduct. The pipeline connecting the two will transport a slurry of gilsonite particles of ¼-in. and less and water.

Goodner said last week that his company estimates its reserves of gilsonite, all in an elliptical area 10 miles wide and 60 miles long, at more than 16 million tons. He said this is the equivalent of about 90 million barrels of crude oil and ample supply to keep the plant in operation more than 50 years.

Petrochem Hub?

Imperial project promises to spark Sarnia activity

SARNIA, Ont.—An important petrochemical center might be in the making here.

Imperial Oil, Ltd., will build a $25,000,000 plant to produce a wide range of basic petrochemicals. And the company will make nearby factory sites available to firms wanting to take advantage of the new source of supply.

Products will be ethylene, propylene, normal butylenes, isobutylenes, butadiene, aromatic distillates, and aromatic tars. Others can be added.

The plant will be located on 50 acres adjacent to Imperial's 25,000-bbl. refinery, from which it will draw hydrocarbon fractions as basic feedstock. Operation of the two plants will be integrated.

Imperial's plans . . . Construction of the petrochem plant will start in the spring of 1957, with completion scheduled a year later. Engineering work is under way. Principal components will be cracking and fractionating facilities, and an ethylene and butadiene plant.

No capacity figures were mentioned, but the company said volumes would be large. Ethylene capacity is expected to more than double Canada's present output.

The plant will also produce the first butadiene made in Canada by private industry. Butadiene and butylene will be supplied to Polymer Corp. for the manufacture of synthetic rubber.

The future . . . Strategically located Sarnia, on the St. Lawrence Seaway and near important Canadian chemical markets, is already an important chemical center.

Spurred by the new source of basic chemicals and the availability of plant sites, it could well blossom big in the field of petrochemicals.

Imperial has been purchasing land for the plant sites next to the site for its petrochemical facility. A similar movement is being carried out by Phillips Petroleum Co. on the Houston Ship Channel.

Zapata Orders Platform

HOUSTON. — R. G. LeTourneau, Inc., will begin construction immediately on a second offshore drilling platform for Zapata Off-Shore Co.

The first platform, somewhat smaller than the one planned, is drilling its second well in the Gulf of Mexico. The contractor said steel will be available from the company's own electric-furnace mill at Longview, Tex. The platform, to cost $3,250,000, will be built at Vicksburg, Miss. On completion about February 1, it will be floated down the Mississippi and put to work in the Gulf of Mexico.

The triangular structure will have three 145-ft. legs. The deck will have more than half an acre in area with dimensions of 194 by 152 ft.

Land Grabs Doomed

Big military withdrawals to need congressional OK

WASHINGTON. — The House interior committee clamped down on military land grabs last week.

It readied for floor action a bill requiring congressional approval of any withdrawals for military purposes of more than 5,000 acres.

The ban, originally intended to apply to onshore lands, was extended to the Continental Shelf at the urging of the Interior Department. The bill also applies the federal mineral laws to mining and oil development on reservations carved out of public lands.

Interior officials put up a strong fight to protect outer Continental Shelf oil and gas reserves against expropriation by the military. Before the committee approved the bill, Assistant Secretary Wesley A. D'Ewart told it the Defense Department was asking airspace reservations over some 19,000,000 acres of potentially valuable deposits off the coast of Texas and Louisiana. The department now has no power to insist that oil development be allowed to continue in the area.

Development of Continental Shelf reserves is just beginning, D'Ewart explained. The Government has collected some $253,000,000 from leases. But the dispute over the Louisiana boundary has interferred with the program.

Underground Storage Set

SAN FRANCISCO.—Pacific Gas & Electric Co. this winter will have a new source of natural gas for meeting peak loads in the San Francisco Bay area. The company is constructing its first underground storage unit.

The depleted Pleasant Creek gas field in Yolo County, 50 miles northeast of here, will be used for the project. Three existing producers and six to be drilled will permit withdrawals of 80,000 M.c.f. daily from the 2,800-ft. Upper Cretaceous producing zone.

The company will build a 2,640-hp. compressor station for injecting the gas underground. The plant will have a capacity of approximately 36,000 M.c.f. daily.

Processing BRIEFS

EL DORADO, Ark.—Lummus Co. has been awarded contract to construct a second Ultraforming unit at Pan-Am Southern Corp.'s refinery here. The unit, scheduled for completion during the summer of 1957, will have a capacity of 6,200 bbl. per day. The refinery's first Ultraformer was completed in May 1954 and has a capacity of 6,800 bbl. daily.

VENTURA, Calif. — Tidewater Oil Co. will salvage its number four gasoline production plant at Ventura. The 20,000,000 cu. ft. of gas handled daily will be shifted to Plant 2, which will be stepped up with the addition of two 600-hp. compressors. The move is part of a $1,200,000 modernization program just getting under way. Petroleum Combustion Engineers of Los Angeles is doing the work.

SHREVEPORT. — Dedication of Gulf Natural Gas Corp.'s new natural-gasoline plant near Oil City, La., will be July 28. Having a daily capacity of 27,000,000 cu. ft., the plant will process gas from about 2,200 wells in Pine Island field, Caddo Parish. Cost of the installation has been estimated at about $2,350,000. Work on the unit started last fall.

CLEVELAND. — Standard Oil Co. (Ohio) has added an IBM 705, latest type electronic computer, to its accounting offices here. The firm will continue to use a type 650, installed last year.

Sohio's giant electronic "brain" is the second such installation announced. First was by Esso Standard Oil Co. at its Baton Rouge refinery *(The Oil and Gas Journal, May 14, page 14).*

DALLAS.—Centurion Gas & Oil Co. has started operating its new natural-gasoline plant in East Risch field of Jack County, North Texas. The plant has a gas-processing capacity of 4,000,000 cu. ft. daily. It is handling about 2,000,000 cu. ft. from 20 wells. Plans are to connect more wells soon. Gas is being processed by Centurion under contract with Lone Star Gas Co.

RIFLE, Colo.—The Navy will take over and operate the federal Government's shale-oil pilot plant near here until the project is completed. Cmdr. Emory C. Smith announced Navy plans. Properties were taken over from the Interior Department when Bureau of Mines research was ended there June 30 by Congress' refusal to provide sufficient funds.

Casinghead Gas Better Than Water? . . .

. . . Humble Plans New Recovery Method

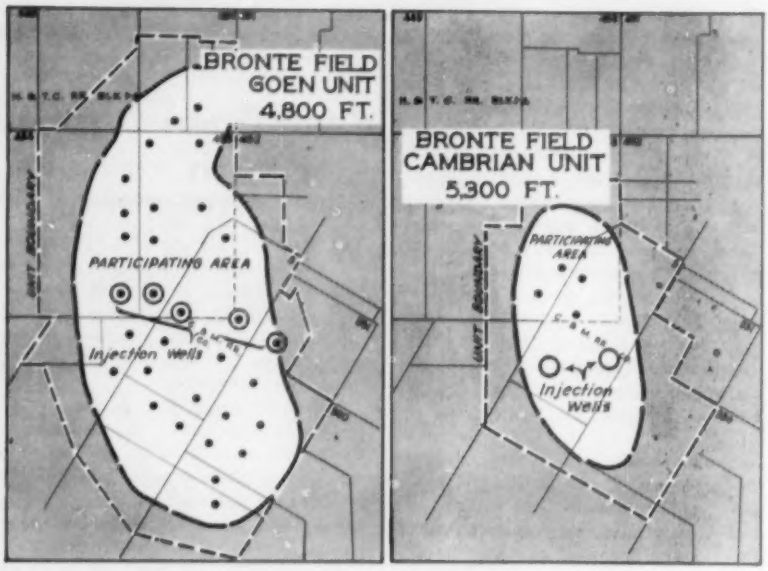
DALLAS.—A new secondary-recovery method, expected to out perform any in general use today, is slated for field testing soon.

The technique calls for injecting rich casinghead gas to effect a "condensing gas drive."

It will get its first full-scale test in big Bronte field, a five-pay field just west of Bronte, Tex., in Coke County. The process is an outgrowth of intensive laboratory work by Humble Oil & Refining Co.

Casinghead gas from four oil zones will be reinjected into Bronte's Goen and Cambrian oil pays. Any gas needed on top of this volume will come from the Bronte Gardner horizon, a gas-producing zone. The field is now in the process of being unitized.

Humble research indicates that the condensing gas drive will recover about 50 per cent more oil from the two pays than would a water flood. Added recovery is expected to be about 4,500,000 bbl. more than for a water flood and roughly 13,500,000 bbl. more than could be produced under primary methods.



The project . . . The Texas Railroad Commission is now considering an application by Bronte operators to unitize the Palo Pinto, Capps, Goen, Gardner, and Cambrian pay zones in the field.

The commission is virtually certain to approve the unit, and, along with it, the revolutionary secondary-recovery project proposed by Humble, as unit operator.

The proposed unit plans to gather all casinghead gas from the Palo Pinto, Capps, Goen, and Cambrian pays and compress it at an existing field plant to an injection pressure of about 2,200 psi. The gases from the various pays reach the plant at pressures ranging from about 4 psi. to about 255 psi.

The rich gas would be injected in the vapor phase through five input wells into the Goen and two into the Cambrian.

Input wells in both reservoirs are in a rough line splitting the middle of the field from east to west. Humble thinks the resulting "line-drive" sweep from center to ends will work better than a dispersed or perimeter type.

The Goen inputs will be converted producers. Those in the Cambrian will be drilled.

Enough rich gas will be injected to fill reservoir space voided by production thus maintaining reservoir pressure. Exact daily injection rates will depend on how much oil the reservoirs are permitted to produce. Input rates probably will average out, however, to about 3,000,000 cu. ft. daily for the Goen and about 1,000,000 cu. ft. daily for the Cambrian.

Producing life of the two reservoirs with the condensing gas drive is estimated at about 25 years. Humble thinks the injection phase of the project will continue for about 16 years. During this period the unit will inject a total of about 20 billion cubic feet of gas. Essentially all producible oil will have been recovered at the end of this period, and the two zones will have become gas reservoirs.

The project will then go into a 9-year "blowdown" phase. Gas injection will be stopped and the rich gas remaining in the reservoir will be produced naturally by existing water drives in the two zones.

An unusual feature of the injection phase of the project is that oil produced from the Goen will be heated to hike volume and liquids content of the gas. And, if found necessary in the future, the unit is prepared to add propane or some other light liquid to the input gas to enrich it further.

Humble thinks there will be no sharp increase in gas-oil ratios.

How it works . . . The gas to be used as the injection fluid at Bronte is unusually rich, containing only 55 to 58 per cent methane.

When injected at roughly 2,200 psi., slightly above the reservoir pressures, it will be highly soluble with the reservoir oil. The gas will swell the reservoir oil, lower its viscosity, and improve the permeability relationship. The gas actually will be absorbed by the reservoir oil. And, in effect, the oil will be washed out of the reservoir.

There will be no sharply defined front. The gas entering the formation will change gradually into a light swollen oil which in turn will gradually change into virgin reservoir oil.

When dry gas is injected into an oil formation, the gas is inclined to finger ahead of the main front in places and bypasses oil because it flows easier.

These gas "fingers" may emerge in a condensing gas drive, too, but the rich gas is so nearly like the oil that bypassing would not occur, Humble thinks.

The condensing gas drive, in theory, should recover a very high percentage of oil in place wherever it sweeps. A water flood, on the contrary, leaves a lot of oil behind in the formation.

A simple comparison of mechanisms of water and the condensing-gas drive can be seen by washing two oil-soaked sponges, one with water, the other with kerosine or some such solvent. Essentially all the oil can be washed out by soaking the sponge in kerosine and squeezing it out a couple of times. No matter how many times you wash an oil-soaked sponge with water, some oil will always remain in the sponge.

Site of the test . . . The Bronte multi-pay field is a north-south anticline in eastern Coke County.

All pay zones have relatively good communication with no faulting. All have bottom water except the Gardner, which has edge water. Gas-oil ratios in all zones are low. All gas produced over lease needs is now being flared.

The field was discovered in August 1948 with a Palo Pinto lime completion at 4,400 ft. The Palo Pinto now has 49 wells and is believed to cover about 2,400 acres. It had produced 2,965,000 bbl. to June 1 and is about 65 per cent depleted.

The Palo Pinto is believed too far gone for a condensing gas drive. It is possible, though, that the zone's present weak water drive may be beefed up by water injection later on.

The Gardner, the gas zone, has four wells and about 2,200 acres. The discovery was completed in July 1949. By the first of June it had produced 2½ billion cubic feet of gas and 69,000 bbl. of condensate.

The Capps was found at 4,600 ft. in September 1954. It has only two wells on a producing area estimated at 1,024 acres. Cumulative production to June 1 was only 5,300 bbl.

Development of the Capps isn't far enough along to tell whether the new technique will work. Early indications are that it will. Rich-gas injection likely will be started here, too, if more information from further development proves it feasible.

The 4,800-ft. Goen now has 30 producing wells on about 1,300 acres. It so far has produced about 1,700,000 bbl. Reservoir pressure was 2,075 psi. when the discovery was made in February 1952. It has dropped only 69 psi. to a present 2,006 psi. Saturation pressure is 885 psi.

Porosity and permeability are high, and viscosity of the 50°-gravity oil is low—about .49 cp. at saturation pressure. The gas-oil ratio is 168:1. About 450,000 cu. ft. of Goen casinghead daily is being flared.

The Cambrian strike was made in April 1954 at 5,300 ft. The zone is in the flush stage of depletion. It has only four wells so far on 463 productive acres. Initial Cambrian pressure was 2,260 psi. Present pressure is 2,130 psi., and saturation pressure is 390 psi.

Average porosity is 11 per cent and average permeability 202 md. Oil viscosity at saturation pressure is .52 cp. Cambrian gas-oil ratio averages 168:1.

Both the Goen and the Cambrian have active water drives, and both are undersaturated.

Humble asked the commission to approve also a net gas-oil ratio rule for both the Goen and Cambrian which would give credit for gas injected in added oil allowable. The company recommended that the Goen MER be set at 3,000 bbl. a day for the condensing gas drive, as compared with a 2,000 bbl. daily for an active water drive.

The company asked that the present 82-bbl.-per-day producing rate of the Cambrian be continued due to a lack of data on which to base an MER.

Where it can be used . . . It appears that the condensing gas drive method of producing a secondary crop of oil, if it proves out at Bronte, may have a fairly wide application, though not nearly so wide as water flooding.

An undersaturated reservoir is a necessity.

Probably the biggest drawback to its use in many otherwise qualified pools would be the lack of a large-enough source of rich-enough gas. Humble doesn't rule out the possibility, however, that relatively dry gas could be souped up with light liquids.

Actually, it appears the new Humble technique will flush out oil in about the same manner as the high-pressure gas-injection process pioneered so successfully in Block 31 Devonian field in West Texas by Atlantic Refining Co.

The Atlantic process, however, involves injecting dry gas at very high pressure—about 4,000 psi. It is regarded as feasible only in reservoirs with bottom-hole pressures of 3,000 psi. or above.

If the Bronte test proves out, it means that many of the shallower, lower-pressure reservoirs may also qualify for similar greatly-increased recoveries.

Conoco Now Third-Grader

Continental starts selling "Royal Super" in 24 Houston stations; no immediate plans to blanket marketing area

HOUSTON. — Continental Oil Co. has joined the superpremium gasoline trend.

The company started marketing its new "Royal Super" gasoline on an experimental basis in the Houston area last week.

In announcing the experiment, Harry J. Kennedy, Conoco vice president, declined to reveal the octane rating of the new motor fuel. "We don't want to start any crazy octane race," he explained. Kennedy added, however, that the octane number is higher than that of the company's present premium gasoline.

Other sources revealed that "Royal Super" has an octane rating "in the neighborhood of 100."

The new gasoline is in competition was Golden Esso Extra gasoline which was introduced recently by Humble Oil & Refining Co. in Houston and several other Texas cities.

Conoco plans . . . Continental's experimental gasoline, like the 100-octane plus Golden Esso Extra, uses separate pumps from those which dispense regular and premium grades. Each of the new fuels sells for about 3 cents per gallon more than the standard premium.

"This Houston experiment is strictly designed to test the demand for such a gasoline," Kennedy said in announcing Conoco's entry into the superpremium gasoline field. "We have no immediate plans for introducing the gasoline generally in our 27-state marketing territory."

The Continental vice president said "Royal Super" was developed at the company's research laboratories at Ponca City, Okla. It is being sold at 24 of the 51 Conoco service stations in the metropolitan Houston area.

Like other ultra-high-octane gasolines recently introduced, "Royal Super" is designed for the higher-compression engines of certain late-model cars and many 1957 models.

Continental's cautious trial of the three-grade system of gasoline distribution is on a much smaller scale than that of Humble and its affiliated company, Esso Standard Oil Co.

Esso results . . . Esso Standard has been selling superpremium for several weeks in half a dozen cities along the Eastern Seaboard and Gulf Coast. By the middle of August, Esso's new gasoline is expected to be available to three-fourths of its customers from Maine to Louisiana.

Esso recently revealed that in early marketing tests its Golden Esso Extra accounted for 22.5 per cent of total gallonage sold at stations offering the new grade. Stations covered by the survey are in New Orleans; Memphis; Baltimore; Washington, D. C.; Elizabeth, N. J.; Eastchester, N. Y.; and Summerville, Mass. *(The Oil and Gas Journal, June 25, page 68).*

The current move toward introduction of new grades of gasoline started last February when Sun Oil Co. began selling five grades in Florida *(The Oil and Gas Journal, February 27, page 82).*

MILLIONTH WELL LOG run by Schlumberger is examined by, left to right, Bill Gillingham, Schlumberger executive president; Ed Hamner, Humble chief of exploration; and Jack Neath, Humble chairman.

Schlumberger Hits 1,000,000

HOUSTON.—The oil industry and Schlumberger Well Surveying Corp. have passed another milepost.

On July 11, Schlumberger performed its one-millionth field operation; and it was Schlumberger's founders who ran the first log for the oil industry 29 years ago. The well that brought the total into seven figures is Humble Oil & Refining Co.'s 1 Danbury Gas Unit No. 6 in the Danbury field of Brazoria County, Texas.

On hand for the history-making electric log were some of Humble's and Schlumberger's top executives. Among them were Jack Neath, Humble's chairman; Ed Hamner, chief of exploration for Humble; and Bill Gillingham, Schlumberger's executive vice president.

Besides the "brass," there was another notable present for the event—Robert M. Cox, driller and relief tool pusher on Humble's Rig 22 where the log was run. Cox also was a driller on the rig when Humble ran its very first electric log. That was in 1930, 4 years before Schlumberger was incorporated into its present form. Gillingham's association with Schlumberger also predates the 1934 incorporation.

First log in '27 . . . Electric log No. 1 was run in a well in the little field of Pechelbronn, France.

The Schlumberger brothers, Marcel and Conrad, got the idea while experimenting with an electric geophysical technique. Electric geophysics never got very far, but electric logging has. The man who made the tool for that first well-logging job, H. G. Doll, is now Schlumberger's chairman of the board. Both Schlumberger brothers are dead, but Marcel's son, Pierre, is president of the company.

In that first well, the logging tool had to be cranked out of the hole by hand. The logging cable was rigged over a sheave hung in the derrick. The Schlumberger brothers tied a bell onto the sheave so that it rang every time the sheave made a complete revolution. Each time the bell rang, cranking stopped, and the instrument was read.

Since the sheave was 2 ft. in circumference, the readings were 2 ft. apart. They were recorded by hand and later plotted into a curve.

The first electric log in the United States was run in 1930 for Shell Oil Co. of California. The first on the Gulf Coast came the following year. Schlumberger now performs about 100,000 jobs each year.

Gulf-Type Barge Heads West

LOS ANGELES.—California's first gulf-type drilling platform has started its 45-day voyage to Los Angeles, via the Panama Canal.

The platform was constructed at Avondale, La., and then towed to Grange, Tex., where the caissons were loaded aboard for the trip to the West Coast. The platform will be assembled at the Los Angeles Ship Building yards in Wilmington, Calif., after it arrives in mid-August.

It was fabricated by the Offshore Contractors Co., a group composed of Healy Tibbitts Construction Co., Raymond Concrete Pile Co., Delong Corp., and Bechtel Corp.

The barge was built for Monterey Oil Co., Humble Oil & Refining Co., and Seaboard Oil Co. It will be used on a core-drilling program on a 1,280-acre lease beginning 1 mile offshore between Huntington Beach and Newport Beach.

Importers Report

Middle East plans of over 50 firms received by ODM

WASHINGTON.—More than 50 oil companies reported to the Office of Defense Mobilization last week on their planned imports of Middle East crude through September.

The reports are being studied to determine how well the importers will comply with Director Arthur S. Flemming's request for a slash of 90,000 bbl. daily from original programs, sent out last month.

Flemming asked for a cut that would bring third-quarter imports to a level 4 per cent below the average of actual receipts in the first half of the year.

If the reduction is made, he said, it may not be necessary to hold the public hearing in September which he earlier said would be called if a new study by the Cabinet fuels committee's task force shows that imports are still excessive.

As the reports began to come in, Flemming told Congress he was emphasizing that the cuts should be made by the individual companies on a voluntary basis.

Any other approach, he explained, might involve the importers in anti-trust law violations.

Gas-Lobby Probe Extended

WASHINGTON.—The Senate lobby investigating committee is expanding its probe to cover the activities of a number of oil and gas companies.

A staff inquiry into the lobbying activities of individual companies was ordered by the committee last week. The study probably will be made during the recess of Congress.

Chairman John L. McClellan of Arkansas refused to disclose the exact direction of the new inquiry. He said only that it was "preliminary."

About a dozen oil and gas companies have been selected for a study of their lobbying activities, McClellan said.

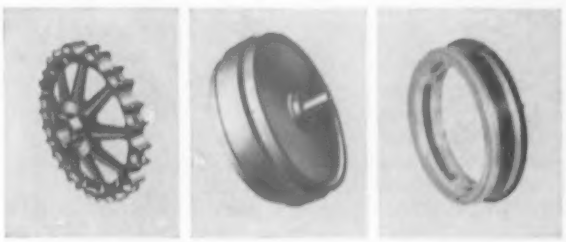
Anybody ever tell you there's no difference in parts?

Take sprockets, for example. Caterpillar *original* sprockets feature *deep-hardened teeth* with tough cores to withstand shock loads. CAT* original idlers have steel disc construction, with steel treads *flame-hardened* for greater wear. Cat bellows seals are of self-aligning face-type design. They help keep lubricant in and dirt out, even on the dustiest job. You're *sure* of new machine performance with original parts like these.

With substitute parts, can you be sure of anything?

Better see your Caterpillar Dealer's Parts Representative—and get Cat original parts every time.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.



Caterpillar sprockets, idlers and seals are the result of over 50 years of track-type tractor manufacture. So don't be fooled — there *is* a difference in parts. Why take chances with substitutes?

CATERPILLAR*

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L.P.G. Floods Set

• Projects are scheduled by two Texas independents in heavy crude fields

AUSTIN. — L.P.G. injection to increase oil recovery continues to appeal to independent operators in shallow heavy-crude fields in Texas.

Wherry & Green, Houston, last week was granted a permit to inject butane and propane in a shallow pay in Taylor Ina field of southern Medina County.

The commission earlier approved a similar project for Chicon Lake field in the same county of Southwest Texas.

Wherry & Green owns 42 oil wells on three leases totaling 420 acres in Taylor Ina. The wells produce from a sand at 900 ft. The field has been active since 1921 but has been abandoned several times.

Wherry & Green started operating there in 1953 and, according to R. B. Wherry, spent $250,000 developing the acreage. New wells produce about 4 bbl. a day, Wherry said. He added that he knew of no well in the field that ever paid out the cost of drilling and operation.

But Wherry thinks commercial oil is there, and that an L.P.G. flood would recover a large portion of the estimated 1,500 bbl. per acre-foot in place.

Pilot flood . . . First the operator plans to convert the 1 "B" Wilson to injection service and pump about 300 bbl. of butane a day at 400 psi, through perforations from 880-89 ft.

If successful, the pilot would be extended throughout the acreage on a five-spot pattern.

Wherry told the commission he expects injected butane to lower viscosity of the oil and build up reservoir pressure. Casinghead gas will be injected as well if enough is produced.

Gasoline Plant Construction Co., which handled one of the first successful butane floods for Shamrock Oil & Gas Corp. in the Texas Panhandle, is planning the project.

Chicon Lake project . . . Winthrop Corp. won commission approval of its plans to inject propane into the shallow Navarro sand under its G. H. Wagoner and James King leases in Chicon Lake 40 miles to the northeast of Taylor Ina *(The Oil and Gas Journal, June 25, page 68)*.

Chicon Lake is another old field producing highly viscous crude (about 550 cp.) from the Navarro at about 300 ft. Gravity of the oil is 17.5°.

Winthrop plans to inject 10 bbl. of propane daily and increase the volume to 50 bbl. daily if the field responds.

The company believes it can reduce oil saturation in the Navarro from 41.4 to 21 per cent of pore space. It feels it can increase ultimate recovery by 375 bbl. of oil per acre-foot of pay if it can realize a propane-sweep efficiency of 50 per cent.

Drill Makes Error

Search for gas results in promising crude discovery

FORT ST. JOHN, B. C.—A search for gas to supply Westcoast Transmission Co., Ltd.'s, Peace River line may have turned up an important oil discovery near this northern community.

Pacific Petroleums, Ltd., and associates are reported to have found light-gravity crude in the Permo-Penn formation while drilling in the middle of Fort St. John gas field.

The discovery was reportedly made at 45 Pacific Fort St. John. A drill-stem test at 6,385-6,413 ft. recovered 5,750 ft. of clean oil of 40-43°-gravity. Drilling is continuing.

The well is located in the same general area as Boundary Lake, British Columbia's only producing oil field. It is in the area of a farmout deal Pacific has with Imperial Oil, Ltd., involving some 2,500,000 acres of the Pacific group's land.

Imperial farmed out the acreage under agreement by Pacific to spend $9 million on exploration in the 3-year term of the contract.

The agreement gave Pacific all oil and gas reserves it had discovered, plus future reserves of gas found on the acreage. Imperial has rights to all oil discoveries, with Pacific getting an interest.

Canadian Wildcat Scores

ESTEVAN, Sask.—A promising oil strike has been made in the most active area in Canada and the Williston basin.

Gridoil Freehold Leases, Ltd., brought in 2-12 Gridoil-Glen Ewen, 45 miles east of here. It was the first well in a 22-well program planned for Saskatchewan by Gridoil, a wholly owned subsidiary of Anglo-American Exploration Co.

A drill-stem test in the Charles-Mississippian formation at 4,065-4,092 ft. recovered 620 ft. of light-gravity oil and no salt water. The well will be taken down to test deeper formations.

The discovery is in the same general area where Imperial Oil, Ltd., has turned up 9 producers out of 18 wildcats drilled.

Industry BRIEFS

AUSTIN. — The Texas Independent Producers and Royalty Owners Association is sponsoring a meeting of Texas independents "later this month" to plan further action on imports and to see what can be done about a "critical shortage of steel goods." A. E. Hermann, TIPRO president, said importers will decide by their actions within the next few days "whether their imports will be limited by formal governmental action."

DALLAS.—Lone Star Gas Co. plans to convert a dead well in a small Pettet reservoir in Milam County, Texas, to gas-storage service. It estimates the reservoir, at about 7,700 ft., covers 125 acres and will hold roughly 75,000,000 cu. ft. of gas.

HOUSTON.—New York Associated Oil & Gas Co. will expand its drilling equipment rental division and channel earnings from this source into oil and gas production. The Houston firm was listed last week on the American Stock Exchange. It operates 11 equipment rental yards in Oklahoma, Texas, New Mexico, Louisiana, and Wyoming.

LOS ANGELES.—The Western Oil and Gas Association and the Pacific Coast office of the A.P.I., Division of Production, will move to new offices this week. The relocation involves a move of only 1 block from their old address at 510 W. Sixth Street, to the National Oil Building, 609 So. Grand Avenue. Prior to this move, the W.O.G.A. had occupied offices at the Sixth Street address for more than 26 years.

MIDLAND. — Magnolia Petroleum Co. plans to drill two L.P.G. storage wells on the site of its big tank farm 2 miles east of Midland. The wells, projected to 2,650 ft., will store products prior to their entry into the company's 8-in. L.P.G. line to the Gulf Coast near Beaumont.

LOS ANGELES. — Sunset Oil Co. will be merged into International Mining Corp. The surviving company will be Sunset International Petroleum Corp. Directors of both firms have approved the merger, and the Securities and Exchange Commission last week issued a ruling clearing the way for it. Stockholders of International mining will vote on the plan August 20. It already has approval of Sunset stockholders.

With 10 years on corrosive waste gases this Crane Valve is still maintenance-free

THE CASE HISTORY—For over 10 years, a large integrated refinery has handled corrosive waste gases on its refinery flare line with this 10-inch No. 47X Crane cast steel 150-pound valve. Used as the main gate valve, it is operated about once a month.

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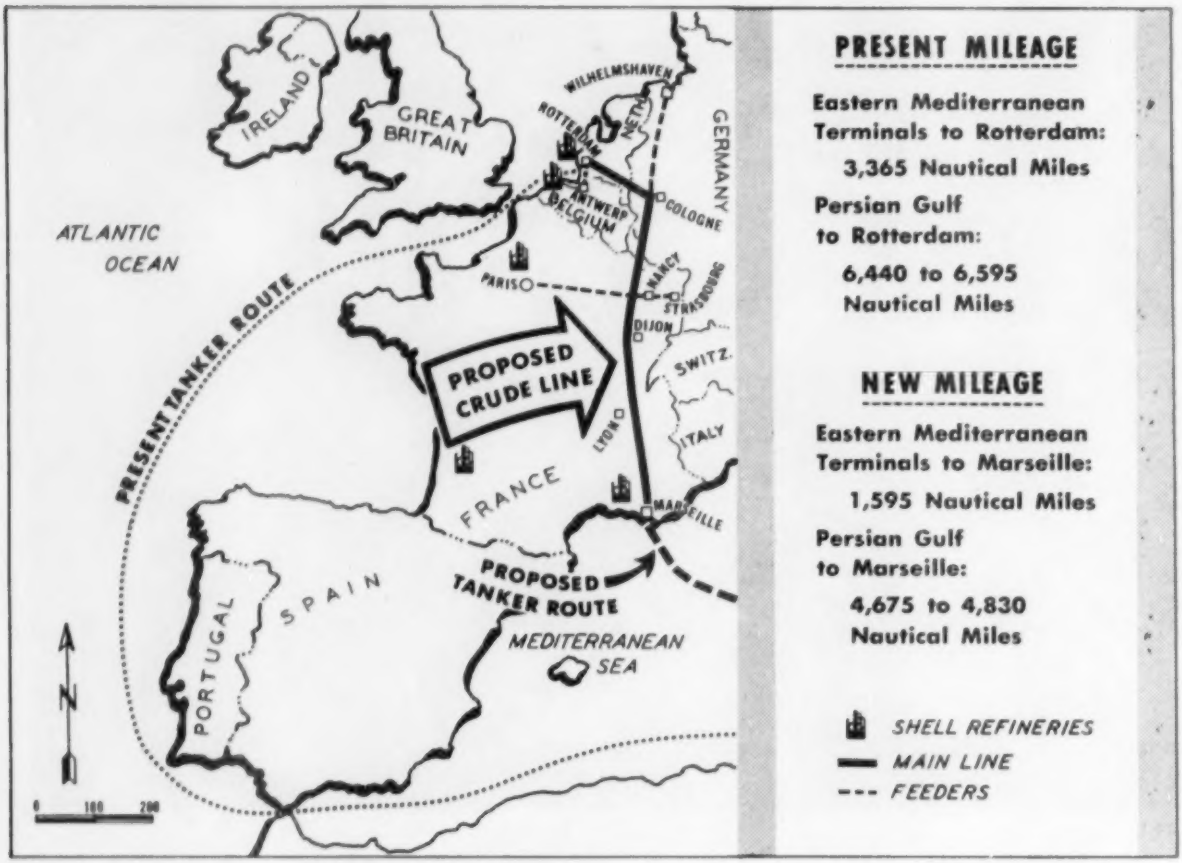


Trans-Europe Crude Line Considered

ROYAL DUTCH-SHELL and other companies are considering a pipeline to carry crude across Europe from the Mediterranean to the North Sea.

The line would begin at Marseille and terminate at Rotterdam. It would be about 700 miles long and run through Eastern France, Luxembourg, West Germany, the Netherlands, and Belgium.

Cost of the project might run as high as $280,000,000.

If built, the line would alter the pattern of crude movements to Europe and the long-range refining picture on a big part of the continent. Here's why:

. . . **Tanker hauls** from the Persian Gulf through the Suez would be about one-fourth shorter and one-fifth less expensive.

. . . **Refineries** could be built near the centers of consumption rather than at sea ports. A potential capacity of 800,000 bbl. daily would insure adequate supply for future expansion of new plants.

A final decision has yet to be made on the line. No official proposal has been made to the French Government.

One new refinery has already been proposed in conjunction with the line.

A Shell group member and other firms have formed a company to build a feeder line for a projected 80,000-bbl. daily plant on the Rhine River at Strasbourg, France.

Participants in the company include Caltex, Esso Standard, Mobil Oil Francaise, Petroles B.P., Francaise des Petroles, Petrofina, and German companies.

Cost of the refinery would be about $70,000,000, and the feeder line, $41,000,000. The natural marketing area for a major Strasbourg refinery would be Lorraine, Southwest Germany, and parts of Switzerland.

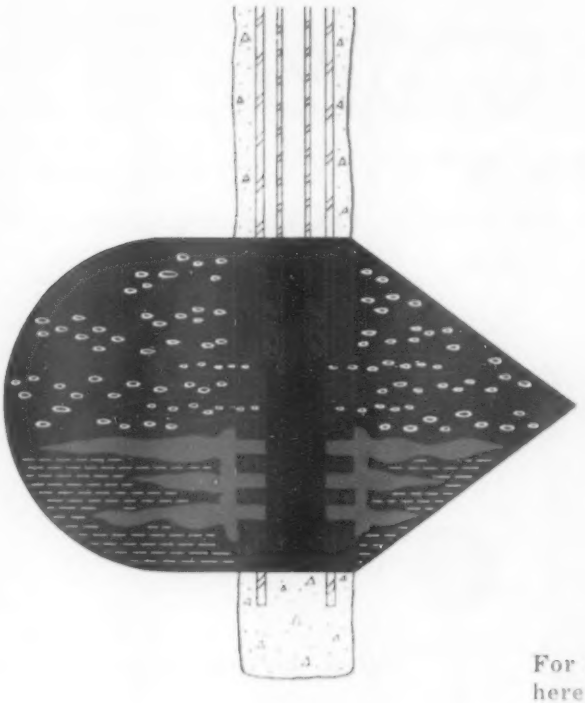
Feeder line to Paris . . . The main trunk would be a 30-in. line. It would run northward past Lyon and Dijon, then northeast past Nancy and on to Cologne, West Germany. From Cologne, the trunk would run northwest into the Netherlands and to the Rotterdam terminal. A branch might run to Antwerp, Belgium.

The terrain along the line's path offers some advantages. The Rhone-Saone River Valley, which the line would follow 250 miles to Dijon, runs generally along the straight line route from Marseille to Cologne. The valley separates the foothills to the French Alps on the east and the mountains of southern France.

The main feeder lines would extend from Nancy west to Paris and east to Strasbourg.

Feeders also would branch out to the Saar and other points.

The line could possibly join with the proposed line from Wilhelmshaven to Cologne. Nine companies which met



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this month to decide whether to originate the line at Rotterdam or the German port have postponed the decision until July 18.

Shell has dropped out of the German pipeline project. It would have had an 18 per cent share in the line.

But at the same time, the company made clear its willingness to use the facilities if the line is built.

Save tanker miles . . . While a tanker trip to Marseille from the Persian Gulf would be one-fourth shorter, mileage from the Eastern Mediterranean would be less than one-half.

The present run from Trans-Arabian Pipe Line Co. and Iraq Petroleum Co., Ltd., terminals on the Eastern Mediterranean to Rotterdam is 3,365 nautical miles. The same trip from Sidon to Marseille is 1,595 miles.

The voyage to Rotterdam from the Persian Gulf varies from 6,595 miles from Abadan to 6,440 miles from Ras Tanura. The trip to Marseille from the same points is 4,830 and 4,675 miles.

The shorter distance to Marseille and the large volume of crude delivered there would markedly ease the job of the world's tanker fleet.

The saving of one-fifth on tanker rates from the Persian Gulf also would be greater on the Eastern Mediterranean-to-Marseille trip. The base rate from the Eastern Mediterranean to North Sea ports is currently 27 shillings ($3.78) per ton. The rate to Genoa, which is about the same distance as Marseille, is 13 shillings, 1 pence ($1.83) per ton.

Effect on refining . . . Initial throughput of the line would be somewhere between 480,000 and 670,000 bbl. daily.

Present refining capacity in Belgium, France, and Netherlands, and West Germany is about 1,100,000 bbl. daily. But by the time the line could be built, new plant construction will have raised the capacity considerably.

Capacity of the five Shell Group refineries in Belgium, France, and Holland totals 357,000 bbl. daily.

Only two of the refineries would lie near the trunk line. But they are the two largest: the 75,000-bbl. Berre l'Etang plant, 22 miles from Marseille, and the 220,000-bbl. Pernis plant at The Hague.

Other Shell Group plants are a 3,000-bbl. refinery at Ghent, Belgium; a 50,000-bbl. refinery at Petit Courone, near Le Havre; and a 12,000-bbl. refinery at Pauillac, near Bordeaux

Shell is expanding its Hamburg, West Germany refinery, to 56,000 bbl. daily. But this plant is some 200 miles from Cologne.

Mediation Offered

U.S. tries to settle fuss between I.P.C., Lebanon

THE United States last week offered to arbitrate the dispute between Iraq Petroleum Co., Ltd., and Lebanon over just how much the oil company should pay the little eastern Mediterranean country for permitting oil to cross its borders. Lebanon accepted but I.P.C. had no immediate comment.

The U.S. offer came after I.P.C. warned that it might divert its pipeline system around Lebanon and the Lebanese Government made an implied threat to seize I.P.C. properties *(The Oil and Gas Journal, July 9, page 75)*. In a week of charges, warnings, and counterwarnings, the Lebanese minister of state clarified earlier remarks that started the new controversy.

Saeb Salem, Minister of State, said last week that his earlier remarks regarding the seizure of I.P.C. installations had been misinterpreted. He explained last week that Lebanon will consider all I.P.C. property within its borders as government property only if I.P.C. does divert the flow of Iraq oil around Lebanon. He said that under a 1931 agreement Lebanon is privileged to claim the properties at any time after May 25 of this year if the oil company's pipeline operation in Lebanon is halted.

The Lebanese Parliament recently passed a new law imposing income taxes on I.P.C. and other corporations operating in the country. I.P.C. has been exempted from such taxes in the past. Because the oil company has rejected Lebanon's demands for new pipeline tolls the government made the new tax law retroactive to 1952.

Last week U.S. Ambassador Donald Heath offered to mediate the pipeline royalty dispute and the offer was accepted by the Lebanese minister.

Good Cuban Strike Is Being Completed

THE Cuban discovery 4½ miles southwest of Jatibonico field is being completed as a producer after a drill-stem test indicated it may be the island's best strike so far.

Cuban-American Drilling & Exploration Co., Dallas, set 5½-in. casing to 7,157 ft. The well, 1 Catalina, will be the island's first producer of high-gravity crude from a formation that deep *(The Oil and Gas Journal, July 9, page 72)*.

During the drill-stem test flowing pressure reached 57 psi. The test ran for 35 minutes on a 20-ft. section at 7,107-37 ft. Top and bottom chokes of ¼-in. and a 570-ft. water cushion were used.

When the well was shut in, surface pressure reached 100 psi. in 15 minutes and was still climbing. After 1,190 ft. of pipe was pulled, the well unloaded the water cushion and about 900 ft. of 35°-gravity oil. Another 535 ft. of pipeline oil and 35 ft. of oil and gas-cut mud also were recovered from the stem. There was no water.

Initial bottom-hole pressure was 1,000 psi. and final pressure 3,400 psi.

A 20-ft. core was cut from 7,137 to 7,157 ft. after the test. The top 5 ft. was limy fractured shale with oil shows. The last 15 ft. of the core was black waxy shale. Initial tests indicated potential of 25 bbl. per hour.

The well is located 2 miles south of the town of Jatibonico in the central basin, which can expect increased exploratory activity as a result of the strike. It was drilled on a large anticlinal feature on acreage farmed out from Trans Cuba Oil Co. and Cuban-Venezuelan Oil Voting Trust.

Survey Starting in Bolivia

Bolivian Gulf Oil Co. starts this week on a 3-month airborne magnetometer survey of the 3,750,000-acre area on which it holds exploration rights in Bolivia.

The subsidiary of Gulf Oil Corp. obtained the rights to the area 3 months ago under contract with Yacimientos Petroliferos Fiscales Bolivianos, the government oil agency in Bolivia. In return for the acreage, Gulf has agreed to furnish $5 million in financing a crude-oil pipeline to cost $10,500,000 to give the country a Chilean seacoast outlet for its crude *(The Oil and Gas Journal, April 2, 1956)*.

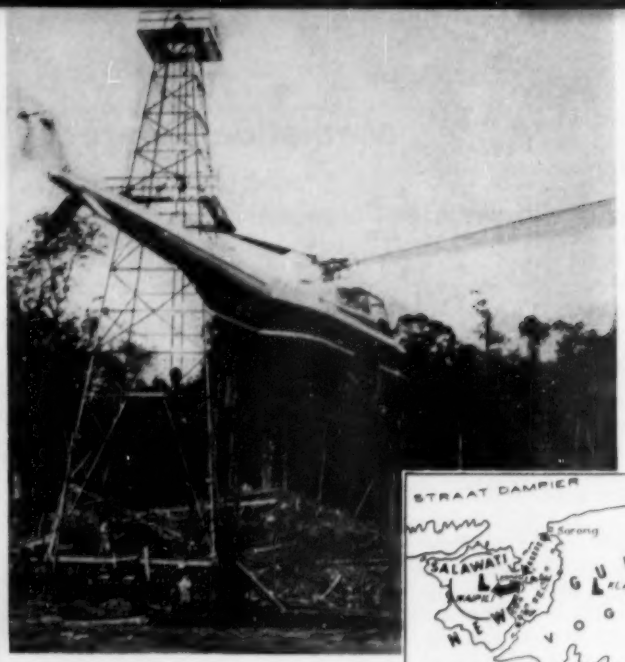
Aero Service Corp., Philadelphia, will do the aerial survey work.

Guatemala to Grant Acreages

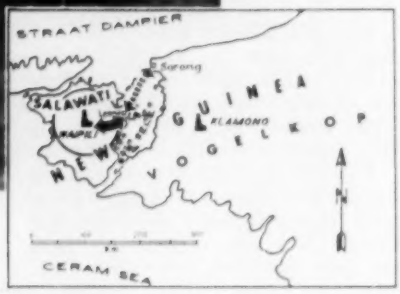
Oil companies bidding for concessions in Guatemala have settled the problems of overlapping applications and the government expects to grant acreages within 45 days.

Concessions will be awarded to 21 companies, including most of the American majors. The grants have been delayed for several months due to the overlapping bids. Companies worked out the problems among themselves at the request of the government *(The Oil and Gas Journal, June 11, page 105)*.

One concession already has been awarded to a subsidiary of Signal Oil & Gas Co. A total of 53 concessions will be granted, including the Signal tract.



FLIGHTS were made from Lenna to Waipili after materials were barged from Sorong.



From supply depot . . . To drill site, it's . . .

. . . Jungle Wildcatting by Helicopter

AN unsuccessful wildcat in the remote jungle swamps of Salawati Island in West New Guinea has captured the imagination of foreign-operating oil companies in spite of the fact that it was a dry hole.

The test, called Waipili, is the first well anywhere in the world to use helicopters to haul in drilling equipment, erect a rig, and completely maintain and supply a drilling operation. The fact that this can be done has sparked interest among oil companies with remote and often inaccessible operating territory. Equipment manufacturers and aircraft builders also are interested in the operation.

Netherlands New Guinea Petroleum Co. (N.N.G.P.M.), which drilled the test, is already calling the operation "the saga of a successful failure." Standard-Vacuum Oil Co. and the Royal Dutch-Shell Group each have a 40 per cent interest in the company and the remaining 20 per cent is held by Caltex.

As in most cases of improvisation, the decision to embark on the airborne drilling operation was influenced by the matter of cost. The Island of Salawati swelters one degree off the equator just a few miles off the coast of West New Guinea. It consists mostly of dank rain forest and its jungle is all but impenetrable. The drilling site selected is 15 miles from the Strait of Seleh which separates the island from the New Guinea mainland.

To build a road inland to the Waipili site and across the island's swamps would have taken a full year and the cost would have been prohibitive. Another equally expensive 3 months would have been necessary to drag in the necessary drilling equipment.

The helicopters did the job in just 5 weeks.

How it was done . . . The first of two S-55 Westland-Sikorsky helicopters chattered to a landing cleared at the Waipili site on September 25, 1955. By late October, the drilling rig had cleared the top of the jungle and housing and supply sheds were up. By November 4 the well was spudded.

The company calls the whole operation a story of versatility of the modern helicopter. The eggbeaters, operated under contract by Bahamas Helicopters, Ltd., amazed the drilling crews by what they could do.

The copters not only brought in the drilling derrick, section by section, but actually helped erect it. Hovering over the substructure, the helicopters positioned girders and legs and later functioned as "sky hooks" for other operations.

The rig used in the operation was a Brewster N-2 with an 87-ft. derrick. It is rated for a depth of 4,264 ft., but this was exceeded in the 4,800-ft. Waipili test. Three Gardner-Denver mud pumps were used and all prime movers were General Motors 98-hp. diesel engines.

All the materials for the operation were crated and assembled on the New Guinea mainland and then barged across the Strait of Seleh to a landing dock at Lenna. Each piece was carefully classified and given a priority tag. At Lenna the helicopters picked up the units of equipment and then set them down at Waipili. The round-trip averaged 30 minutes.

Carrying a maximum load of 1,375 lbs., the copters made the 15-mile flight at a minimum altitude of 5,000 ft. so pilots could keep emergency landing spots hacked out of the jungle in sight at all times. The bulkier loads were suspended beneath the helicopters with a steel sling.

This shuttle between the rig site and the landing dock was maintained every day and the aircraft moved 210 tons of equipment and supplies to the well site before the well was spudded in. Another 240 tons maintained the operation during drilling. It took 364 flights—190 hours of flying time—to do the job.

Six months after it all started, N.N.G.P.M. had nothing but a very expensive dry hole to show for its trouble. But, the company feels it passed a milestone in proving that it could be done.

After the decision to abandon the hole to the already rapidly encroaching jungle, the helicopters put the operation in reverse and flew all the equipment out again and back to Sorong on the mainland.

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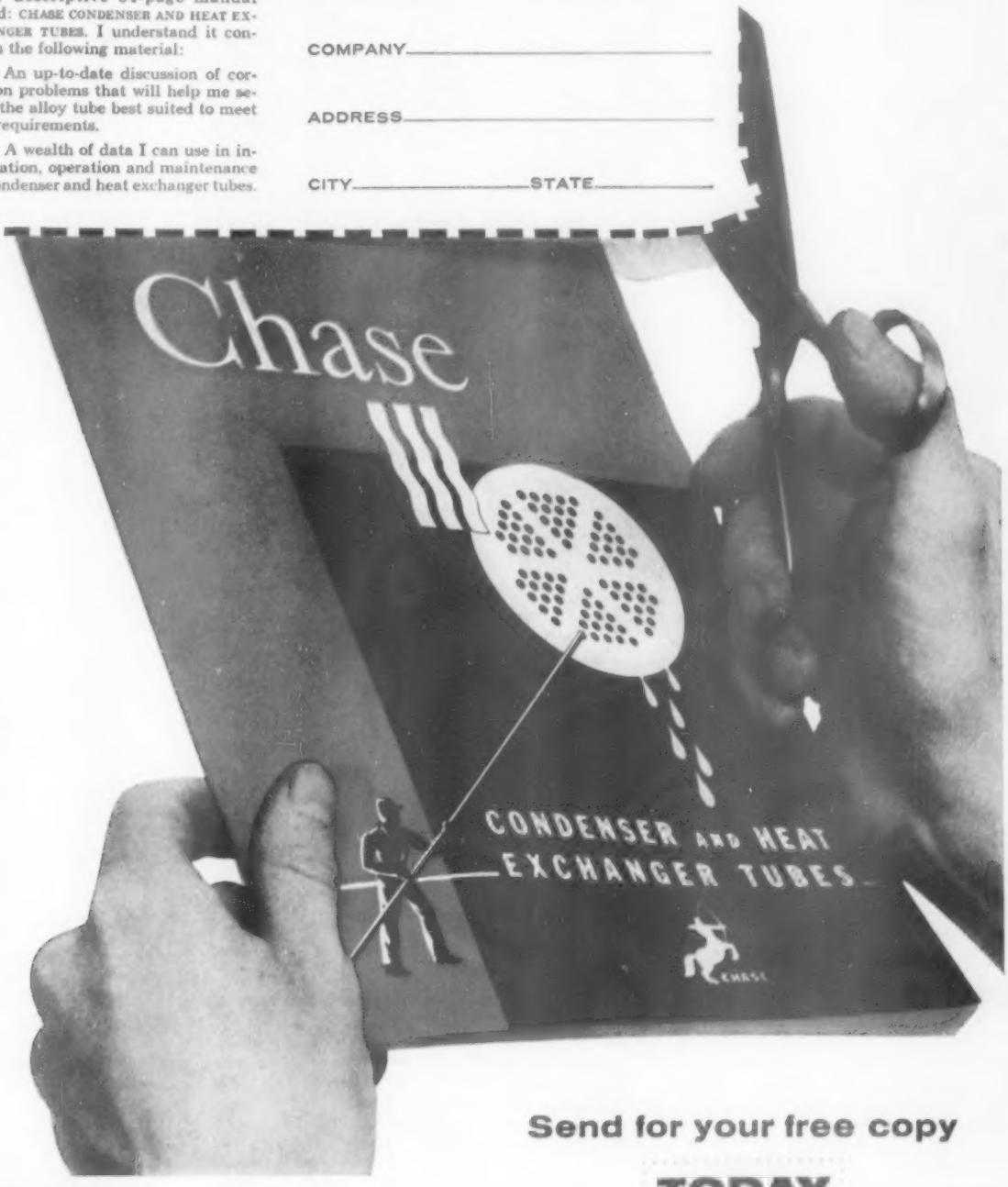

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NEW GUINEA supply point is framed by copter which aided in "operation airborne wildcat." Maneuver saved 14 months, has others eying airlift for working remote areas.

impressed by the performance they have already agreed to furnish equipment that can be broken down into segments weighing no more than 2 tons. This will make it possible to double the near-5,000-ft. depth of such an airborne well. Heavier helicopters are also being designed to haul loads up to 4,000 lbs.

After the entire operation was carefully analyzed, N.N.G.P.M. engineers came up with definite conclusions, pro and con, with regard to their experiment.

Here are those they regard as advantages:

. . . **Time is saved** by omitting road building.

. . . **Money is saved** in a case of drilling at a topographically difficult location where road building costs would have been prohibitive.

. . . **Geological information** is more quickly available.

. . . **More wells can be drilled** in the same amount of time with the same equipment.

. . . **Less weather influence** occurs during drilling operation. Once a road is built in the tropics, heavy rainfall makes them unusable for long periods of the year.

. . . **Time saved** in rigging up and dismantling the rig because of the helicopter's ability to pick up the equipment with less handling.

Here are the advantages for a road as compared with the helicopter:

. . . **No need for dismantling** equipment if it can be moved in one piece.

. . . **A road is already** available if a commercial discovery is made.

. . . **In case of prolonged drilling** operations, the helicopter costs could far exceed the expense of road construction.

. . . **A short and/or inexpensive road** will always be more attractive than helicopter transports.

Denver Firm May Buy Trinidad Holdings

COLORADO OIL & GAS CORP. of Denver is dickering for half and controlling interest in Trinidad Petroleum Co., Ltd., which has an 11,000-bbl.-daily production and substantial land holdings in Trinidad.

The Denver firm is a subsidiary of Colorado Interstate Gas Co. It would buy the stock from British Controlled Oil Fields, Ltd., of Montreal, which is in the process of liquidation. The other half of the stock is owned by the public.

President W. C. Norman and two Colorado Oil & Gas vice presidents have been in Trinidad making an evaluation of the property under consideration. The officials with Norman were J. S. Bowman and E. Trafford.

If it acquires control, Colorado will expand its exploration operations. The Trinidad firm has substantial undeveloped acreage and offshore concessions.

Texaco-Trinidad deal . . . In Trinidad's big oil deal, talks have been suspended between the British Colonial office and The Texas Co. in connection with the latter's proposed purchase of Trinidad Oil Co., Ltd.

Texaco officials requested the suspension, until July 26, in order to conduct some on-the-spot investigations in Trinidad.

Italy Gets Tough

● New bill imposes stiff restrictions; heavy favors given state-owned agency

ITALY'S Chamber of Deputies last week passed by an overwhelming margin the country's new "tough" oil bill that favors the state-owned oil agency.

The burdens which the law imposes on private oil companies, both Italian and foreign, are almost certain to keep the major oil companies of the world out of Italy.

To become law, the bill must now be approved by the Italian Senate. This is not likely before autumn, but reports from Italy last week indicated the government plans to issue exploration licenses under the bill's terms before that approval.

The bill's passage was made possible by the support of the country's dominant Christian Democrats and two small parties.

The left-wing Socialists and Italy's Communists have always approved the bill, which comes very near to nationalizing the country's oil industry.

Thirty Monarchists in the Chamber of Deputies walked out without voting when their amendment to liberalize the bill to favor private capital were rejected.

Where it hurts . . . Here's why companies will shun Italy if the bill becomes law: A major oil discovery will mean turning over 82.6 per cent of the profits to the government.

The bill contains a sliding scale of royalties and other taxes ranging from 46.6 per cent of the net income on small production to the maximum of 82.6 per cent for a large output.

The monopoly held by Ente Nazionale Idrocarburi, the state-owned agency, in the 18,000-sq. mile Po Valley is kept intact.

In other parts of the Italian peninsula, E.N.I. will compete with private industry on what the bill describes as an equal footing.

Strict limitations . . . The exploration area of any company is limited to 740,000 acres, with no more than half that area in any one of the 17 regions into which Italy has been divided.

A limit of 198,000 acres may be retained for development after production is found.

A limit of only 7,413 acres may be retained around each discovery well. E.N.I. is given the right to purchase the acreage which a discovering company must give up.

Welded Orange-Peel Segments Form Head for Propane Tank

This large hemispherical head, made by welding seven orange-peel segments and one dome plate, is one of several identical heads fabricated for C. F. Braun & Co., Alhambra, Calif., for propane tanks supplied to Tide Water Associated Oil Company's new refinery at Delaware City, Del. The formed segments were made from ⅝-in.-thick firebox-quality Bethlehem plates, in accordance with the API-ASME code. Diameter of the propane-tank head: 133 in.

The uniform quality of Bethlehem plates makes them ideally suited to this type of work. Whenever welding is required in the fabrication of any type of vessel for the oil and gas industry, use of Bethlehem plates, combined with good welding techniques, gives assurance of sound welds.

Bethlehem plates are made in a full range of sheared and universal mill sizes—a range sufficiently wide to meet virtually every requirement. A letter or phone call to the nearest Bethlehem sales office will bring you full information.

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BETHLEHEM STEEL

BETHLEHEM STEEL

by Gifford L. Hitz

ALLOY STEEL HEADER, with cold-extruded nozzles. Fig. 1.

COLD-EXTRUDED HEADER containing 45° miter welds. Fig. 2.

Better Piping and

Smoother contour of nozzle, easy fit-up,

NEW cold-extrusion techniques are being used to produce better prefabricated piping assemblies for refineries and chemical plants. Important savings in welding costs and inspection time are inherent advantages of the new process.

Component parts which formerly had to be hot-forged, cast, or flame-cut and fabricated by welding are being cold extruded at the Paola, Kans., plant of Fluor Products Co. The resulting extrusions have high strength, smooth surface finish, and highly uniform wall thickness.

The unheated steel is subjected to mechanical pressures of 100,000 to 400,000 psi. Confined in a die, the metal is forced to flow under compression around the contours of the die.

The process differs from cold-drawing. In cold-drawing the metal is pulled around a die, stressing the metal in tension. Extrusion pushes it into or through the die under compression.

New development . . . Cold extrusion is considered by most metal-working authorities to be only in the beginning of its development. Progress is limited by equipment and tooling methods now available. An indication of what may be expected, however, is the spectacular results achieved by the ordnance and automotive industries.

They consider the ability to flow cold steel to required contours and extremely close tolerances to be an industrial advance of major order.

Introduction of the process to the manufacture of piping and vessel components was made possible by the development of new machinery, by new tool and die engineering, and by the advent of higher-strength die steels. New die-lubrication techniques also are required.

Typical Extrusions

An example of what is being done at the Paola plant is offered by the multiple outlet header (for a Platforming furnace) shown in Fig. 1. The steel used was seamless alloy pipe (2¼ chrome 1 moly, A.S.T.M. Spec. A335 P22), 10¾ in. in outside diameter, and with a ¾-in.-thick wall. As many as eight openings for 5-in., Schedule 80 pipe were cold extruded in each header pipe, including those containing 45° miter welds (see Fig. 2).

Center-to-center and centerline location tolerances were held within 0.06 in. Height of the machine beveled face was maintained uniform within 0.005 in. Close tolerances were important due to the exacting fit-up required in the heliarc welding used in fabricating the assembly.

These assemblies previously had been fabricated by "stubbing in" the branch lines to a header pipe, or had been cast from specially made patterns. They have been found to be subject to failures and leaks when placed in service. The cold-extrusion process was turned to when it was found that use of hot-forged headers would result in prohibitive delay and excessive costs.

Another example of the ability of cold extrusions to do a difficult job is the gas-transmission header produced for Oklahoma Natural Gas Co. (Fig. 3). Two 12¾-in-o.d. openings at 90° of each other were required in 16-in. line pipe. A special die was made for the second opening. Otherwise the job was accomplished on standard production schedules. Illustrating the simplification and flexibility of design provided by the process, 3-in. and 6-in.-diameter extrusions also were made in the headers.

Pulsation dampeners . . . These units, used in natural-gas compressor stations, are also made by this technique. Due to the severe service conditions under which they operate, freedom from fatigue failure is of prime importance.

A 30-in.-diameter dampener head in which a 16-in. outlet nozzle has been cold extruded is shown in Fig. 4. Thickness of the steel in this head, nominally 1 in., actually exceeded 1⅛ in. Material was carbon steel.

The smooth contour of the extruded nozzle was specified by the design engineers to reduce pressure drop through the dampener. Easy fit-up to

Author is engineering consultant to Fluor Products Co.

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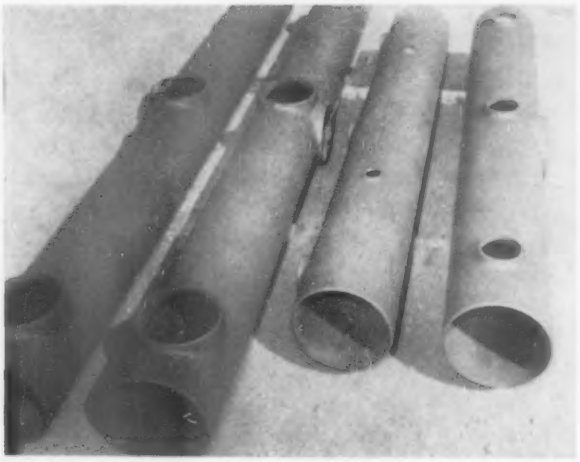
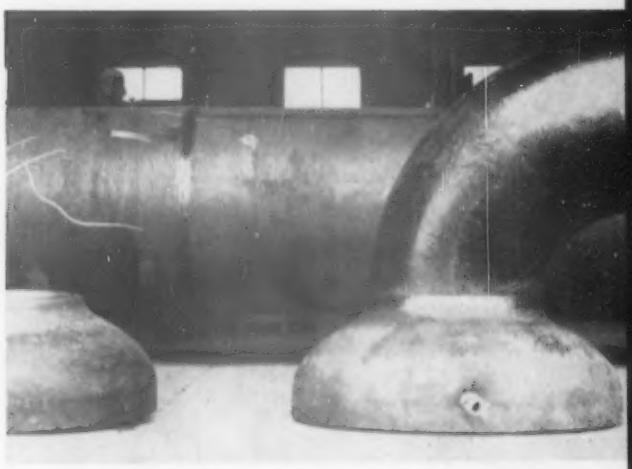


GAS-TRANSMISSION HEADER produced by cold extrusion for Oklahoma Natural Gas Co. Fig. 3.



A 16-IN. OUTLET NOZZLE has been extruded in a 30-in. diameter dampener head. Fig. 4.

Vessels by Cold Extrusions

and elimination of reinforcing pads cut costs and welding time

connecting fittings, and elimination of the heavy reinforcing pads formerly used, cut welding time, material, and inspection costs. Dampeners of this type are certified under the A.S.M.E. unfired pressure-vessel code.

Properties of Cold Extrusion

Before the advent of cold extrusions, hot-forged fittings were generally considered the best available. If the properties of a hot-forged fitting are desired they can be provided by annealing the cold extrusion.

An annealing heat treatment after working will produce the same properties in cold-worked steels which would have resulted if the material had been hot worked and then annealed. However, the general result of hot working is to decrease the strength of steel and increase its ductility.

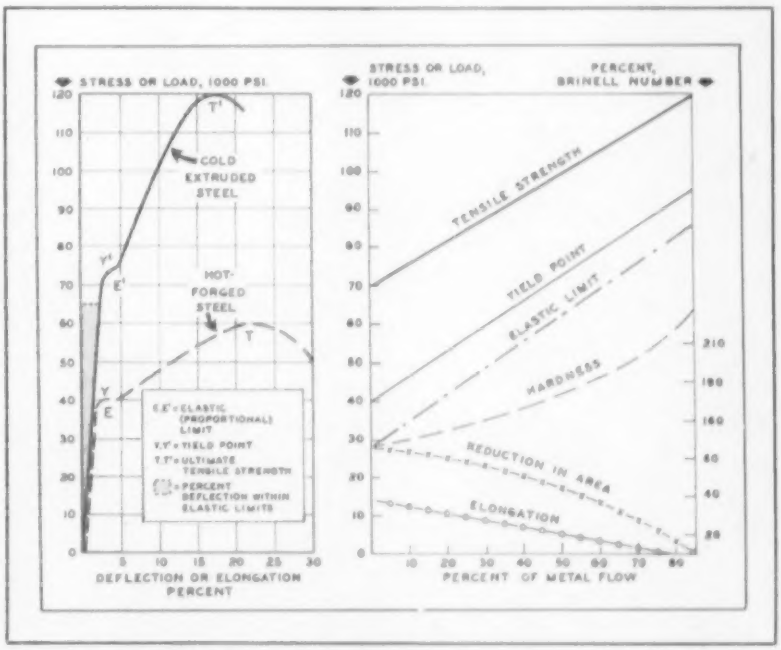
Although often claimed as a desirable feature, actually, under the severe service conditions commonly met in the refining and petrochemical industries, designers of pressure vessels and piping systems cannot use this ability of steel to stretch when stressed beyond its yield point.

The reason is that if a ductile fitting is so stressed and does yield and stretch in service, it has done so in the cold-work range below the critical temperature of transformation. It has been stretched, thinned, and cold-work hardened under tension. The high-ductility feature of the hot-forged fitting thus has been lost; a thinned, cold-deformed-in-tension part remains.

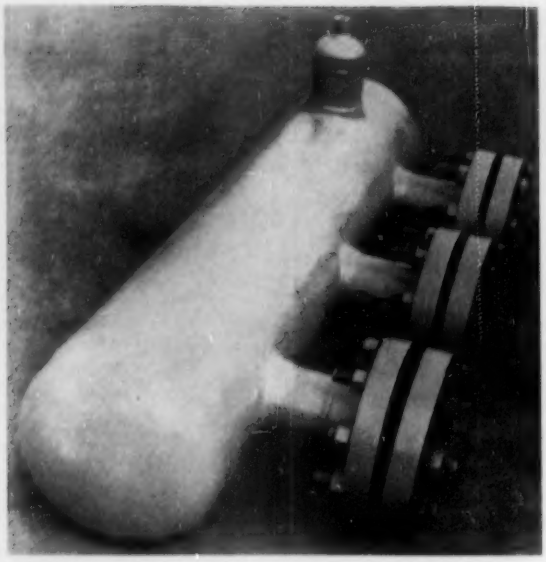
Increased elastic limit . . . In evaluating the advantage of the increased strength and toughness which cold extrusion imparts to steel, two facts are particularly important:

First, acceptable engineering design (as delineated by the A.S.M.E. Code for Unfired Pressure Vessels and for Pressure Piping) does not permit stressing beyond 50 per cent of the yield strength of the steel used.

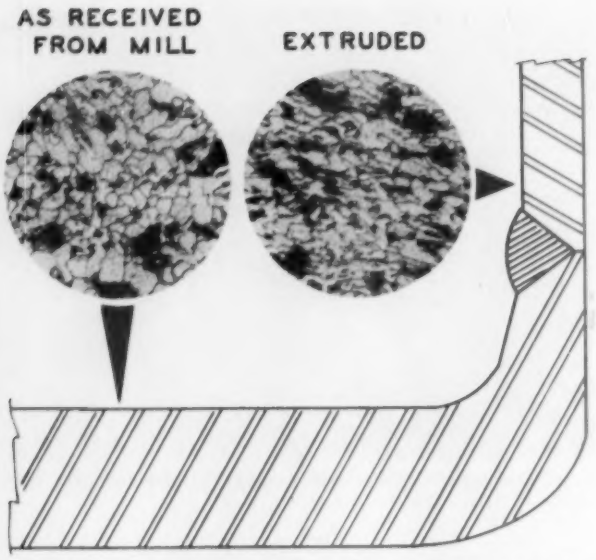
Second, vibration, pulsation, and other external sources will cause some motion in all piping systems. This motion must be absorbed by the steel within its elastic and endurance limits



STRESS AND DEFLECTION for cold extruded and hot-forged steels. Fig. 5.



PRESSURE VESSEL made by cold extrusion was designed for 1,400 psi.; did not fail at hydraulic pressures of 4,200 psi. Fig. 6.



SMOOTH CONTOURS result when joining cold-extruded nozzles to pressure vessels. PHOTOMICROGRAPHIC STUDIES help explain reason for improved physical properties of cold extrusions. Fig. 7.

— which are well below the yield point — if the system is to remain in operation.

Higher yield strength imparted by the cold-extrusion process increases the ability of the steel to deflect within its elastic limits (Fig. 5). Thus it can absorb the motion of pulsation and vibration without impairing its endurance. Should a surge of pressure considerably beyond the design pressure occur in the piping system, the higher ultimate tensile strength of the cold-extruded portion can withstand pressures nearly double that which a similar hot-forged part could withstand without failure.

The relationship between stress and deflection for cold extruded and hot-forged steels is illustrated in Fig. 5. As shown, if a specimen is subjected to increasing pressure, it gives slightly due to its elastic properties. Up to the elastic limit (E-E'), deflection is directly proportional to the stress or pressure; if the pressure is withdrawn, the specimen recovers its original form.

Effect of cold extrusion on hot-rolled alloy steel pipe (2¼ chrome, 1 moly, A.S.T.M. specification A 335 P22) is shown in Fig. 5-A.

Strength tests . . . Strength and toughness of cold extrusions have been demonstrated by tests carried out in the Fluor testing laboratories at Los Angeles. The pressure vessel shown in Fig. 6 has a design pressure of 1,400 psi. It was subjected to pulsating and steady hydraulic pressures up to 4,200 psi. without failure.

Stress-coat and strain-gage readings showed that use of cold-extruded nozzles, without additional reinforcing or padding, had resulted in a vessel of high, uniform strength. As shown in Fig. 7, a section of one nozzle revealed the connection had smooth contours. Also there was no stress-raising notch effects and changes of thickness which result when reinforcing pads or saddles are used.

A photomicrographic study of a section cut from one of the alloy headers shown in Fig. 1 offers further insight into the reasons for the improved physical properties of cold extrusions. The two photographs in Fig. 7 were taken from this study. The photo at left shows the grain structure of this steel as received from the mill. The one at right shows the grain structure of a section taken near the top of the extrusion, where maximum metal flow had occurred.

The dense, compressed grain structure of the cold extrusion, elongated in the direction of metal flow, provides a continuous grain fiber free of discontinuities or voids. Since the inherent hardness of steel increases with carbon content, the greater strength of the extruded metal may be derived in part from the rearrangement of the carbides in pearlite form. In other words, an effect similar to that of a higher-carbon steel may be realized.

Heat treatment . . . Various heat treatments after fabrication can be used to obtain desired properties in the finished assembly. For example, the Platformer furnace headers in Fig. 1 were given a heat treatment after connecting heater tubes had been welded on. This provided a grain structure which would give maximum stability under high-temperature service.

A test to destruction was carried out on a cold-extrusion at Paola before an A.S.M.E. boiler code certified inspector. As shown in Fig. 8, the 12-in.-diameter branch opening was cold-extruded in a section of 16-in. line pipe having ⅝-in. wall thickness. Design pressure was calculated to be 700 psi.

After welding on the stub branch and caps, hydraulic pressure was

TEST TO DESTRUCTION was carried out on this 12-in. diameter branch opening, cold extruded in a section of 16.-in. line pipe. Design pressure was 700 psi.; the branch opening held at 2,200 psi. Fig. 8.

applied. At 1,600 psi. the main shell of the line pipe showed signs of yielding. The cold-extruded portion, being tougher, resisted yield.

Because of the smooth transition from shell to nozzle, no substantial stress concentration could be observed. And, the pipe, given additional strength in much the same manner that the yield strength of 5 XL pipe is increased by hydraulic expansion, continued to withstand increasing hydrostatic pressure. At 2,200 psi., a pin hole developed in the 12-in. circumferential weld, but the cold extrusion showed no signs of failure.

Fig. 9 shows some of the various methods used for fabricating headers. Compared with those resulting from "stubbing in" or assembled from hot-forged tees, the cold-extruded header obviously requires less welding and inspection. Compared individually, cold-extruded headers have numerous other advantages:

- **Stubbed-in construction:** Smooth contours of cold extrusions minimize pressure drop, reduce turbulence and erosion; stress concentrations are removed; fit-up is improved. Material cost for cold extrusions is lower.

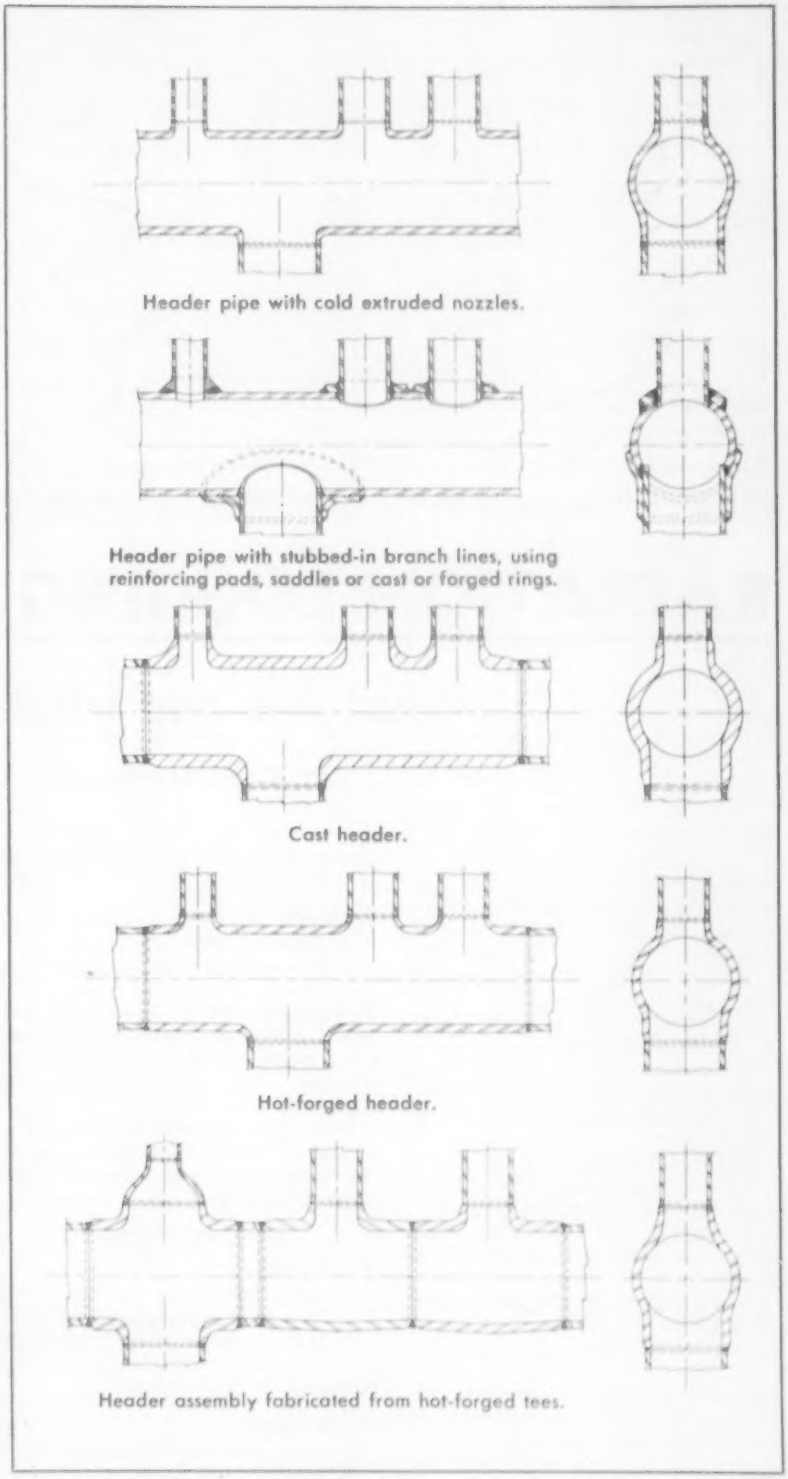
- **Cast headers:** No patterns are required as is the case with this type. Sharp changes in section caused by the wall thickness required in cast headers result in stress concentrations. Welding is simplified because cold extrusions use the identical material used in the rest of the piping system.

- **Hot-forged headers:** Closer dimensional tolerances can be maintained in cold extrusions, and they have improved surface finishes which are free from scaling. Less material is required and production costs are lower than for hot-forged headers.

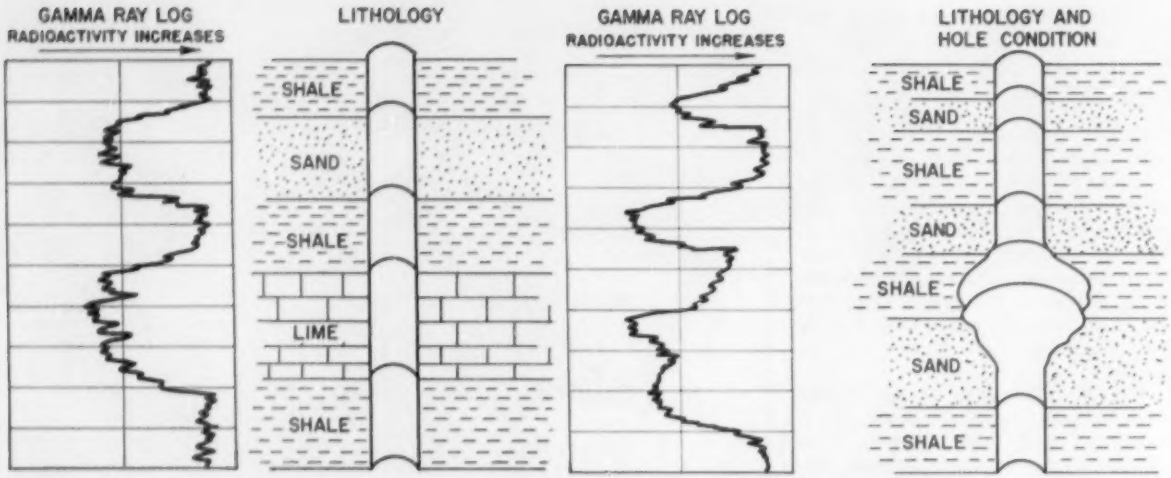
- **Standard hot-forged tees:** Only one-twentieth as much welding is required and better dimensional accuracy is attained with the cold extrusions. A more uniform product results and design is simplified. Because hot-forged tees usually have heavier walls than the pipe to which they are welded, a header with cold extruded nozzles distributes mechanical stresses more evenly over the entire assembly.

Limitations of the process have not yet been established. Presses capable of exerting the tremendous pressures required involve heavy investment costs. Experimental tooling for new applications is expensive. However, as additional know-how is developed, application of cold extrusion techniques will undoubtedly be extended.

Present press equipment and tooling at the Paola plant are capable of extruding nozzles ranging from 3 to 16 in. in diameter. They can be made in piping and vessels 6 in. in diameter and larger, with maximum wall thickness of about 1½ in. Stainless, low-alloy, and carbon steels with carbon content below 0.45 per cent are considered most suitable at present.


Header pipe with cold extruded nozzles.
Header pipe with stubbed-in branch lines, using reinforcing pads, saddles or cast or forged rings.
Cast header.
Hot-forged header.
Header assembly fabricated from hot-forged tees.

VARIOUS METHODS for fabricating headers. The cold-extruded header requires less welding and inspection. Fig. 9.



INTEGRATED natural gamma ray log compared with lithology. Fig. 1.

EFFECT OF HOLE SIZE and bed thickness on gamma log. Fig. 2.

RADIATION LOGGING . . .

What it is and what it can do for you

by E. R. Atkins, Jr.

RADIATION logging depends on the interaction of both gamma rays and neutrons with earth strata penetrated by boreholes. Under suitable conditions, the interpretation of the recorded effects of these reactions are useful for:

1. Location of porous zones which might contain petroleum.
2. Correlation between wells of similar lithologic structures.
3. Determination of gas-oil interfaces in known petroleum reservoirs.
4. Evaluation of the porosity of particular beds.
5. Determination, in conjunction with a collar locator, of the location of casing with respect to beds of interest.
6. Logging of wells which were drilled and cased without obtaining an electric log.
7. Evaluation, in conjunction with an induction log, of oil or gas content of beds drilled with oil-base mud.

Sources of radiation . . . Nuclear radiation may result from any of several reactions. The following list includes radiation which might be detected for logging purposes:

Gamma rays:

1. Natural element decay.
2. Neutron-induced gamma rays.
3. Gamma rays scattered from a gamma-ray source in the logging instrument.

Neutrons

1. Slow neutrons.
2. Fast neutrons.

Radiation detectors . . . Detectors used to date have been of three general types: (1) ionization chambers; (2) Geiger-Mueller tubes; and (3) scintillation counters.

Each type of detector has particular advantages and disadvantages. The following tabulation highlights the characteristics of each:

Ionization Chamber

Advantages:

1. Senses gamma-ray energies.
2. Detects simultaneous gamma rays.
3. May be made as long chamber for averaging gamma rays from a source of extensive length.

Disadvantages:

1. Poor measuring efficiency.
2. Small direct current signal must be amplified.
3. Short chambers will not give sufficient signal to be reliable at practical logging speeds.
4. Exact zero difficult to determine.

Geiger Counter

Advantages:

1. Even fairly weak gamma rays cause a signal.
2. Magnitude of signal current not important, only pulses are counted.
3. Lend themselves to small-diameter instruments.
4. Zero well-defined.
5. Temperature insensitive.

Disadvantages:

1. Will not differentiate between energies of gamma rays.
2. Poor measuring efficiency.
3. Short counters will not give enough counts to be reliable at practical logging speeds.

Scintillation Counter

Advantages:

1. High measuring efficiency.
2. Senses gamma-ray energy.
3. Will detect thin beds.
4. Zero well-defined.

Disadvantages:

1. Reliability is a function of temperature.
2. Effective length of detector limited by crystal opactiy.

Integrated Formation Gamma Log

Most gamma-ray logs made to date have measured the effect of the total gamma radiation upon the detector

Author is research engineer with Union Oil Co. of California, Brea, Calif. Paper given at A.I.M.E. Formation-Evaluation Symposium, Houston, Tex.

PRODUCING

used, recording this value as a function of bore-hole depth. The term "gamma-ray log" is used here in the sense that only naturally occurring gamma radiation is being recorded. An example of such a log is shown in Fig. 1.

The gamma-ray activity of most sediments emanates from the decay of uranium, thorium, or potassium. In the integrated gamma log, the source of the radiation is not discriminated. Hence, the total radioactivity characteristics of various rocks may often be used as a general guide for the interpretation of the integrated gamma log in terms of rock type.

Overlap of radiation . . . It is important to know that the ranges of radioactivity for sands and shales tend to overlap, and the interpretation of a particular log should be based on the best knowledge of the radioactivity of the particular sediments of interest. Fig. 1 shows the usual interpretation of shales, limestones, and sands from a gamma log. Because of the overlapping radioactivity for sands and shales in certain sediments, is has been found in some areas that this interpretation must be reversed.

The conversion of radiation-log data to specific radioactivity depends upon knowledge of bore-hole diameter, instrument size, bed thickness, density of fluid in the hole, casing thickness (if any), and cement density and thickness (if cement surrounds the casing).

Quantitative discussions of these factors are to be found in papers by Blanchard and Dewan[9] and by Fearon and Mardock.[10] In general, it may be said that apparent formation radioactivity as obtained from logs will be less than the true value. The apparent value will increase with bed thickness and decrease as the bore-hole size increases. (Fig. 2).

To date, the integrated natural radioactivity log has been used principally as a qualitative indication of lithology, with primary emphasis on correlation between wells.

. . . Special empirical interpretations

Here are the physical principles of radiation

STRUCTURAL mechanics of atomic nuclei and nuclear reactions are basic to radiation-logging studies. The principal particles of interest in this domain are electrons, protons, and neutrons.

Electrons are the smallest particles of matter (mass$=9.1 \times 10^{-28}$ g.) known to date. The charge on an electron is negative.

A proton is a hydrogen atom from which the external electron has been removed. The charge on a proton is positive and of equal magnitude to the charge on the electron. The mass of the proton is 1,837 times that of the electron.

A neutron may be described as the intimate combination of a proton and an electron so that a particle of zero charge results. Its mass is about equal to that of a proton. Given enough energy, neutrons may penetrate relatively large distances through groups of atoms because neutrons have no charge.

Types of neutrons . . . Under proper conditions, some neutrons can be ejected from the nuclei of atoms to move in space. When first liberated from the nuclei, neutrons have high energy which is exhibited as a high velocity. These newly liberated neutrons are often referred to as "fast" neutrons.

Fast neutrons usually cannot initiate nuclear reactions because their great speed causes them to bounce off large nuclei with only a slight loss of energy (Fig. A). If a fast neutron is first slowed to become what is called a thermal neutron (its velocity and energy approach that caused by the temperature at which the neutron then exists), then it may enter a nucleus and its energy will be absorbed by the nucleus (Fig. B). This may form, in some cases, a different element and cause the release of alpha, beta, or gamma rays. Such changes in matter caused by neutron bombardment will affect a logging instrument.

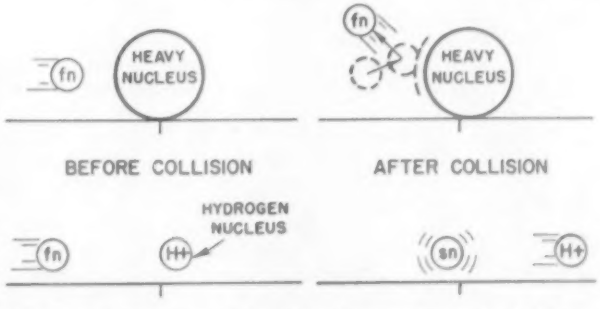
Hydrogen nuclei are most efficient in thermalizing fast neutrons. Because the hydrogen nucleus and the neutron have about the same mass, collision between the two slows the neutron as it imparts energy to the hydrogen nucleus in the form of high speed (Fig. A).

Radiation . . . Nuclear reactions give rise to energy changes which are characterized by the emission of radiation. The three principal types of radiation are: alpha, beta, and gamma rays.

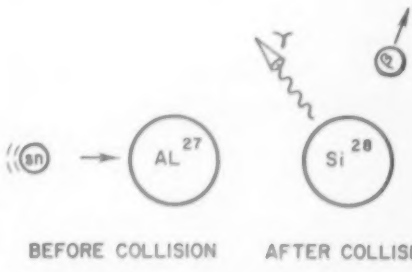
The alpha rays consist of particles which have four times the mass of a proton and carry a positive charge equal in magnitude to two electron charges. These particles ionize gases but do not penetrate solid matter easily because of their relatively large mass. A few sheets of paper will absorb alpha particles.

Beta rays consist of electrons. Beta rays do not ionize gases as well as alpha particles, but a several-millimeter thickness of aluminum is required to absorb most beta rays.

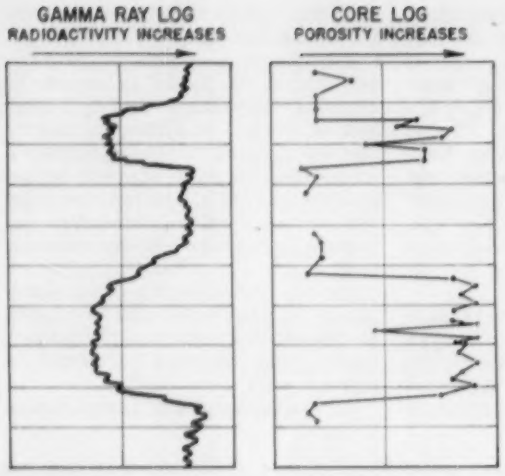
Gamma rays are short-wavelength electromagnetic radiation similar to light and radio waves. The extremely short wave length of gamma rays makes it possible for them to penetrate considerable thicknesses of solid material. Several inches of lead may fail to absorb all gamma rays. Gamma rays ionize gases less than beta particles do.



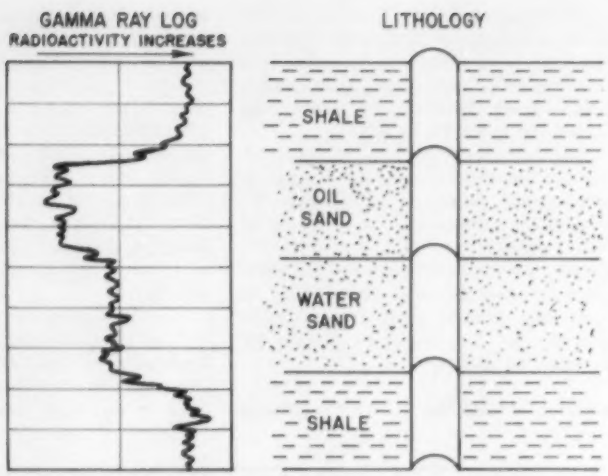
EFFECT of fast neutron collision with a heavy nucleus and a hydrogen nucleus. (Billiard-ball effect). Fig. A.



CAPTURE of a slow neutron by aluminum. Fig. B.



EXAMPLE of typical log where gamma deflection is inverse of porosity. Fig. 3.



EXAMPLE of typical gamma log determination of oil-water interface. Fig. 4.

of integrated natural gamma logs have been found to apply in certain areas. In the Pembina area of Canada,[11] it has been found that natural radioactivity is an inverse function of effective formation porosity. Fig. 3 shows a comparison of a typical log and core analysis in this area which suggests how the integrated natural gamma log can be used for porosity determination.

In this area, it has been established that the effective formation porosity varies inversely with the clay content, and that the radioactivity is a direct function of the clay content. The application of this interpretative technique to other areas may prove useful in the future.

Another unique application of the integrated gamma log has been in determining the location of the oil-water interface in some South Louisiana[12] fields because of the large radioactive potassium content of the formation water. A typical log suggesting the low activity of the water-deficient oil sand is shown in Fig. 4.

As geologists and engineers become more familiar with the causes of the natural radiation and with the characteristics of the petroleum reservoirs of interest to them, other interpretations for specific application to particular fields or zones will no doubt be developed.

Formation Gamma Spectral Log

As previously mentioned, the total or integrated gamma-ray activity does not distinguish between elemental sources of radioactivity. This fact limits the quantitative use of the integrated log. Recently[8 13], field tests have been conducted—with scintillation detectors and pulse-height-pulse-time information-relaying equipment—to obtain energy spectra of naturally occurring radioactivity as measured in bore holes.

It is to be expected that this type of log will provide radioactivity "fingerprints" of the important radioactive constituents of shales and perhaps some sands and limestones. Examples of this type of data will be seen in Fig. 5, which shows the spectra of pure thorium and pure radium as obtained by this apparatus. The differences in intensity and energy of the various peaks and valleys of the two spectra suggest the possibility of identifying both the material and the quantity present with logs such as this.

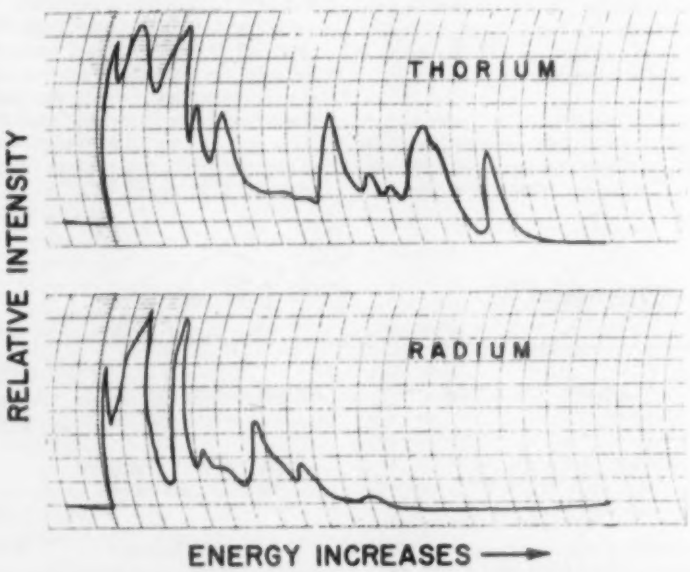
Induced Gamma Formation Density Log

Another recent development in the field of radioactivity logging has been the application of an artificial source of strong gamma rays to the bore-hole wall and the measurement of the back-scattered gamma rays at a distance from the source. This method has been found[14 15] to correlate with formation density or porosity. As with other logging tools which attempt to measure porosity, this device is affected by hole size.

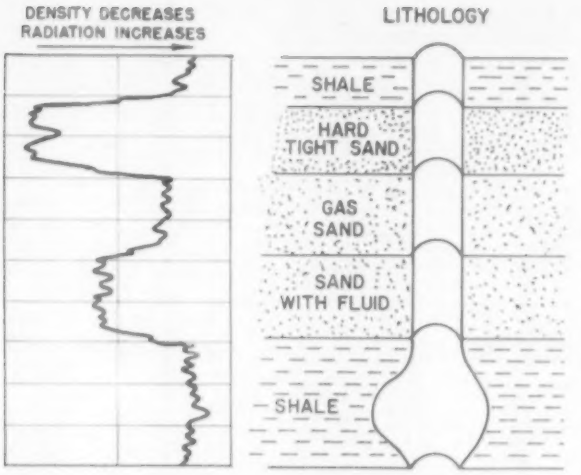
Fig. 6 shows a typical log suggesting how this density log would indicate various formations and hole conditions. Further field testing of this device is proceeding prior to its commercial application.

Neutron Logs

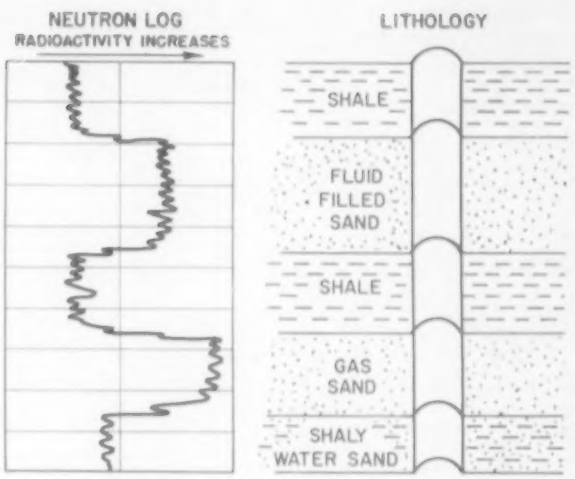
As mentioned in the section on the theory of neutron bombardment, alpha, beta, or gamma rays may be emitted when thermal neutrons react with atomic nuclei. Because only gamma rays



EXAMPLE of radiation spectra of naturally radioactive substances. Fig. 5.



HYPOTHETICAL induced gamma-formation density log. Fig. 6.



COMPARISON of neutron log and lithology. Fig. 8.

may be detected through the steel casing of the logging instrument, the alpha and beta reactions are of little practical value for logging purposes.

However, the fast neutrons from a radium-beryllium source and thermal neutrons (resulting from collisions between fast neutrons and light nuclei) may be backscattered from the formation toward the logging detector to provide two additional sources of radiation which can result from neutron bombardment.

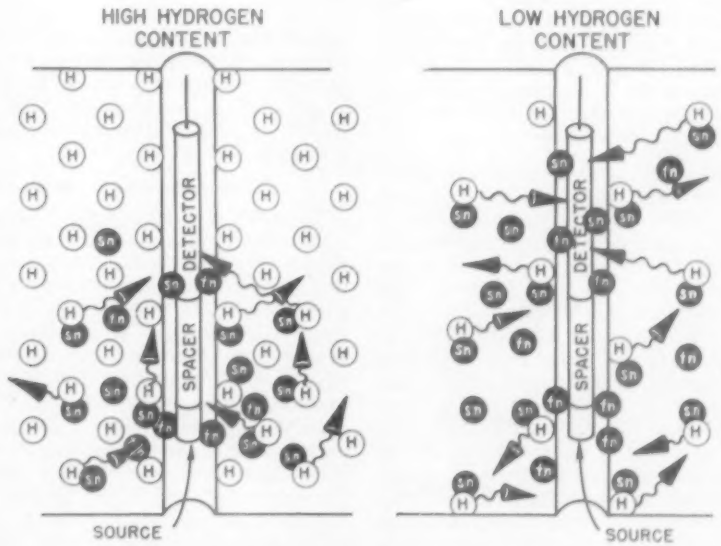
Thus, there may be three general types of neutron logs:

1. Fast neutron bombardment—gamma detection.
2. Fast neutron bombardment—slow neutron detection.
3. Fast neutron bombardment—fast neutron detection.

The neutron-gamma log was the first type of neutron log used[3,15] because the same instrumentation used for natural gamma-ray detection could be easily modified to work in conjunction with a radium-beryllium or polonium neutron source. The gamma rays resulting from neutron bombardment of the formations are generally so much more energetic than the natural gamma rays that it is usually unnecessary to correct this neutron gamma log for the effects of natural gamma radiation.

Shielding is necessary . . . However, gamma rays emitted by the radium in the radium-beryllium neutron source may be backscattered from the formation and reach the gamma-ray detector unless adequate shielding is provided. If the gamma rays from the neutron source reach the detector by backscattering from the formation, they act on the detector in the same way as if an induced gamma formation-density log was being recorded. In this case, however, the neutrons also emitted from the same source will react with the formation to send more gamma rays to the detector.

Thus, two sources of gamma rays will be recorded simultaneously but will not be distinguishable as to source. Because the gamma rays from the two sources react to changes in porosity and hole size in opposite ways, the resulting log is difficult to interpret. A number of shielding methods (to prevent gamma rays from the neutron source from affecting the gamma-ray detector) and electronic discriminating methods (to differentiate the various gamma rays) are now used with varying degrees of success.

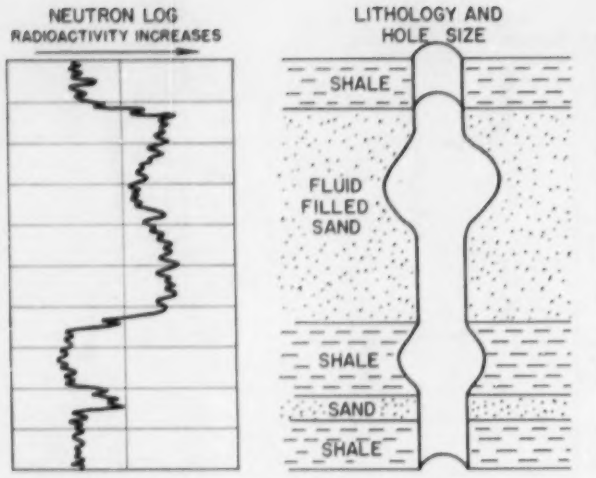


HYDROGEN-NEUTRON interaction. Fig. 7.

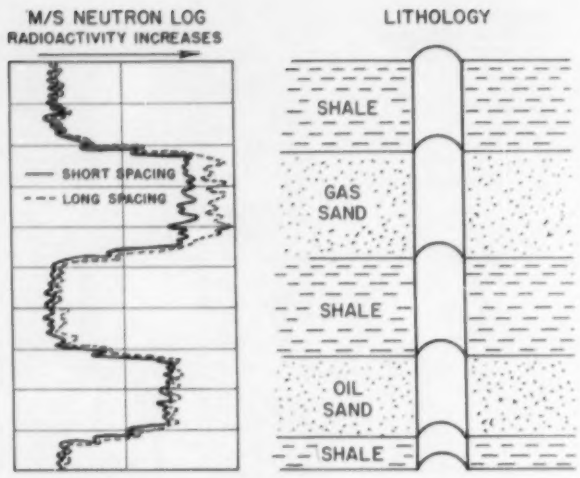
Only neutron sensitive . . . The neutron-slow neutron log[16] may use the same type of neutron source as the neutron-gamma log. But, the detector is sensitive only to slow neutrons. The neutron-fast neutron log may also use the same type of neutron source as the neutron-gamma log, but its detector and information transmission system is constructed to be sensitive principally to fast neutrons.

Note that the three neutron-logging methods described above may use the same type of neutron source, but each detects the effects of neutron reactions with or without hydrogen at a different point in the reaction chain.

It might be expected that some differences would be observed in comparing logs of these three types on the same formations. As yet, such differences have had only a minor effect on interpretation. It may be expected that with more use and study of these logging methods, additional new and useful



EFFECTS of thin beds and hole size on the neutron log. Fig. 9.



HYPOTHETICAL multiple spacing neutron log showing gas sand detection. Fig. 10.

cross-correlations among these methods may be developed—as has been the case with detailed study of electric-log interpretation.

Detection of porosity . . . Regardless of which type of neutron log is run, the principal use of neutron-logging devices in the recent past has been as an indicator of liquid-filled formation porosity[17-28]. Hydrogen is the most efficient neutron-thermalizing element. Liquids or solids containing hydrogen as constituent atoms usually provide a greater density of hydrogen than do gases. For practical neutron-log interpretation, the hydrogen density of oil and water is about the same.

Hence, an increase in fluid-filled formation porosity or hydrogen content will decrease (see Fig. 7) the number of fast neutrons, slow neutrons, and gamma rays in the vicinity of the detector (generally about 18 in. up the hole from the neutron source). This occurs because an increased number of fast neutrons are scattered or thermalized near the source, and an increased number of gamma rays are caused by thermal neutron capture near the source. It is important to remember that the neutron-log interpretation described here is dependent on a space of 18 in. or so between the neutron source and the detector.

Conversely, a reduction in the number of hydrogen atoms around the neutron source (decrease in fluid-filled porosity) will increase (see Fig. 7) the number of fast neutrons and gamma rays in the vicinity of the detector. This will result from a decreased number of fast neutrons being scattered or thermalized near the source and a decreased number of gamma rays near the source caused by thermal neutron capture.

Gas zones . . . In formations containing dry gas, the number of hydrogen atoms present is lower than in a liquid-filled formation of the same porosity. While the liquid-filled part of the formation would be indicated by a medium or low neutron-log reading, the gas-filled portion would be indicated by a high neutron-log reading.

The neutron log will tend to respond to a gas zone of high porosity in about the same way as it would to a liquid-filled zone of lower porosity (see Fig 8). Thus it is necessary to know formation porosity if gas-oil interfaces are to be detected with the neutron log.

The quantitative interpretation of neutron logs generally has resulted in satisfactory evaluation of formation porosity in limestones and dolomites. Argillaceous sands have presented interpretation difficulties because of the high porosity of the clay present in these formations. The hydrogen in the water bound to the clay affects the neutron log in the same way as would fluid porosity. Under these conditions, as shown in Fig. 8, a particular shaly sand bed may appear to have considerably more than its effective porosity.

Difficulties . . . Thin beds and variations in bore-hole size have been recognized as contributing to the difficulties of quantitative neutron-log interpretation.[19 20 22 24 25 26] Fig. 9 presents examples of how thin beds and an oversize bore hole reduce the indicated neutron intensity on a log. It is important to correct for these factors before attempting a quantitative interpretation of the neutron curve. This will be best appreciated when it is realized that an uncorrected low-neutron reading results in estimates of excessive porosity.

When the above factors have been considered, the neutron log has often provided much useful information regarding formation porosity and formation-gas content. It is to be expected that future field and laboratory studies will result in the discovery and evaluation of other variables which affect the interpretation of the neutron log.

Dual logs . . . The use of radiation logs in the field—both neutron and integrated natural gamma devices—has been simplified with the advent of the simultaneous radiation log in 1950.[27] Begun by one company, the simultaneous logging of both the integrated natural gamma log and the neutron log has now become a service which saves rig time for the operator and is offered by most logging companies.

Within a particular service company, the spacing between neutron source and detector is usually standardized. Some field experiments have been performed in which two different spacings are used for successive neutron logs over the same intervals of the bore hole. It has been found in some Venezuelan fields[28] that the differences between the two logs thus run can be used to differentiate gas from oil zones. A typical log of the multiple-spacing neutron service is shown in Fig. 10.

Neutron Spectral Logs

The neutron spectral log[8] is obtained by combining the spectrometer, used for natural gamma spectra, with a neutron source. The phenomena observed are gamma-ray activities of natural elements after exposure to an adequate neutron flux. There are two variables which control the neutron flux: time of exposure and neutron energy.

Field experiments have been conducted using both the regular radium-beryllium neutron source and a particle accelerator[8] which will fit into a bore hole and produce neutrons of energies up to 14 million electron volts. The information obtained from this de-

vice will doubtless increase the utility of radiation logs.

Conclusion

It should be emphasized that the instrumentation and interpretation of radiation logging has improved with its use. General interpretative techniques have been developed, but special interpretation is quite often required for particular areas. As the causes for these special interpretations are better understood, general interpretation will improve, and, perhaps, some new logging methods will be developed.

Acknowledgment

The author wishes to thank the Union Oil Co. of California for permission and the Gulf Coast section of the A.I.M.E. for the opportunity to present this paper. Also, thanks are due those coworkers and service-compeny personnel whose comments greatly assisted in preparing the paper.

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BOOKS

OKLAHOMA OIL FIELD DIRECTORY OF 1956. Published by Market Research Guide, 202 Midco Bldg., Tulsa. Oklahoma City Representative E. G. (Ty) Dahlgren, 615 Liberty Bank Bldg. 1,500 pp. $3 to $7.50 depending upon district ordered, complete set of 11 districts, $5.

This new directory gives a complete listing of names of 3,546 bona fide oil operators, producing from 21,156 oil leases and 71,876 oil wells in 1,341 oil fields of Oklahoma. It is divided into 11 producing districts; this presents a localized picture, such as the Osage and the Golden Trend in the south.

Operators' names are crossindexed for easy reference, showing their leases by section, township, and range. The number of producing wells is given by leases. A field map of each district shows location of the fields, highways, and principal cities.

The directory should prove to be a valuable reference.

GEOLOGY OF THE LATE PALEOZOIC HORSESHOE ATOLL IN WEST TEXAS, by Donald A. Myers, Philip T. Stafford, and Robert J. Burnside. Published by University of Texas. 113 pp. $2.

The Horseshoe atoll is a subsurface accumulation of fossiliferous limestone deposited during Pennsylvanian and early Permian time. Large quantities of petroleum have been produced from reservoirs of the atoll.

This publication points out characteristics of the reef rocks; stratigraphy of rocks beneath, in, and overlying the atoll; structural geology; and origin of the Horseshoe atoll.

ORGANIC CHEMISTRY, Third Edition, by Louis F. and Mary Fieser. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22. 1,112 pp., $10.

This is a complete revision of the second edition of this popular book. New light is thrown on structures and total synthesis of important fatty acids, carbohydrates, peptides, enzymes, alkaloids, isoprenoids, tropolones, steroids, and antibiotics.

The many new developments in the field of protein chemistry are reported. The chapters on the metabolism of fats, carbohydrates, and proteins have been rewritten to include the use of traces and new microbiological techniques. Mechanisms of ionic reactions are further reviewed and extended in an integrated exposition which includes experimental evidence in support of the theory and also instances where present theory is inadequate.

Some 454 brief biographical sketches and vital statistics of past and present chemists associated with new developments are given. They aid the reader in locating material in the literature and make the book increasingly useful for reference.

This new edition should prove extremely useful to industrial research chemists in the process industries as a means of catching up on new developments.

GUIDE BOOK, Sixth Annual Field Conference, Sweet Grass Arch—Disturbed Belt, Montana, 1955. Published by Billings Geological Society, Billings, Mont. 264 pp, $7.50.

Geologists and oil men interested in Montana will want to include this volume in their libraries. This guide book contains 46 pages of road logs that detail the geology in and around the conference area at Glacier National Park. There are several excellent papers on the stratigraphy and structure of northwestern Montana. Seven of the most important oil fields in the area are written up in detail. The regional cross-sections and the detailed electric log and geological information make this guide book invaluable for geologists new to Montana geology.

CONSERVATION COMMITTEE OF CALIFORNIA OIL PRODUCERS-ANNUAL REVIEW, 1955.

An extensive report containing statistical information on oil production, conservation, field changes, committee elections and recommendations, and secondary recovery activities in California.

The book is divided in two sections: Historical section; and statistical section.

NE FIELD AND POOL DISCOVERIES, published as a supplement to the Annual Review by the Conservation Committee of California Oil Producers.

This report contains maps and cross-sections of new fields discovered during 1955. Complete well data are given including operator's name, location of field, and production data.

Note: The Oil and Gas Journal maintains a book department. Write to the READER SERVICE DEPARTMENT, P. O. Box 1260, Tulsa 1, for copies of the book list. Often books reviewed here may be purchased from this source.

NEW OFFSHORE drilling barge of Shoreline Drilling Co. as it appeared at Morgan City, La., during installation of the power package. Fig. 1.

For smooth, efficient power . . .

Electricity Drives Offshore Rigs

This diesel-electric power system features variable voltage at constant engine speed. Electric-motor drives operated from this system provide smooth, instant power.

by R. B. Fairman

DRILLING-RIG power packages unite the advantages of simplified electrical control and time-proven diesel power, and already have proved their versatility in actual service. Such packages are achieving widespread acceptance in the drilling industry. Offshore Co., of Baton Rouge, La., and Shoreline Drilling Co., of New Orleans, recently have put new drilling-rig power packages on offshore rigs.

General design . . . The base rig consists of two skid-mounted engine-generator sets, one 1,370-hp. draw-works-drive assembly, two 600-hp. mud-pump-drive assemblies, and complete controls. Each of the two engines drives two exciters and main generators; these in turn provide power for two motors for the hoisting operation and one motor on each of two mud pumps.

The main engines also drive auxiliary generators which supply power for motor excitation, blower motors, and control. Arrangement of equipment and power switching is such that either one of the engine-generator sets can supply power for all necessary operations for drilling or hoisting. Draw works and mud pumps may be operated singly or in combination.

All motors are controlled by a rheostat, which is operated by hand or foot pedal from the driller's position (Fig. 2). The rheostat has variable positions for hoisting and lowering and a neutral position. A selector switch on the control stand determines main-generator draw works, motor-power combinations.

Mud-pump motors are skid-mounted to provide complete flexibility in set-up with no special mechanical-drive requirements associated with the power package. The power plant, including engines, generators, and main control, may be located wherever desirable. This facilitates weight distribution on barge-mounted rigs and saves setup time on land installations.

Engines . . . The heart of the drilling-rig power package is a six-cylinder, four-cycle diesel engine (Fig. 3). It develops 850 hp. at 1,000 r.p.m. The engine has a 9-in. bore and 10½-in. stroke and is equipped with a water-cooled turbosupercharger operating from exhaust gas.

Cooling is provided either by radiator or shell and tube heat-exchanger equipment. The latter takes advantage of large water supplies in offshore-drilling applications and provides more efficient cooling in smaller space and at reduced expense.

The inline, trunk piston engine uses a solid fuel-injection system. Speed is controlled by a hydraulic-type governor operated by a manual knob and coupled to an indicating dial. A mechanical-safety-overspeed trip is provided to operate in event of governor failure.

Studies have shown that, as a prime mover, the diesel or dual-fuel engine will consume only 15 to 20 per cent of the gas or oil required by a steam plant of equivalent power. Transmission losses in a diesel-mechanical torque-converter drive range from 15 to 25 per cent, compared to only a 12 per cent loss in a diesel-electric drive.

In addition, application of large diesel engines shows a fuel saving of about 10 per cent compared to several smaller engines operating on the same load.

Control features . . . The highly responsive variable-voltage-type electrical system built into the power packages

Author is with Alco Products, Inc., Schenectady, N. Y.

DRILLING

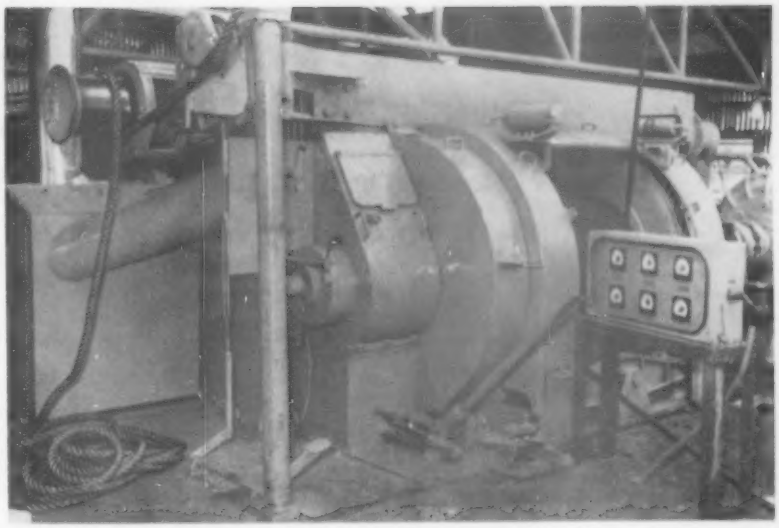
permits variable motor speeds with a constant engine speed. This means that all power built into the package is instantly available—the operator does not have to wait for engine acceleration each time more power is required.

The separately excited, shunt-wound motors combined with the generators of matched characteristics (Fig. 3) reduce the chance of chain-drive failures that may occur with series-wound motors or with shunt-wound motors and unmatched generators. This eliminates the need for very complicated controls used to prevent shock loads and overspeed inherent in a series motor.

The simple control is essentially an amplifying system that produces only the power needed at a given moment. A variable-voltage exciter regulates the generator output, as opposed to various other control installations where a change in engine speed is required to produce a change of power at the motor end. The drive is a torque-multiplier and variable-speed clutch which transmits maximum power without excessive heat losses at speeds from zero to maximum.

The generator, armature-output voltage is a direct function of its shunt-field strength. And the motor speed is a function of the voltage it receives from the generator, therefore, any movement of the rheostat at the start of the system affects the motor output.

This system eliminates current-waste, a problem with control installations where generator voltage is constant. The manufacturer's engineers feel it also is more efficient than systems with variable generator and engine speeds. A time-lag in power application, more complex controls, and additional wear and tear on equipment are eliminated.



FRONT VIEW OF DRAW-WORKS assembly. Note the controls on the assembly and the instrument panel conveniently placed for easy access. Fig. 2.

Design features . . . Each power package is self-contained, requiring no independent or auxiliary source of power outside of the main-power units. Each engine generator set is equipped with an auxiliary generator, more than large enough to power all main drilling equipment. The auxiliary generators are large enough to provide for lighting, bug fans, shale shakers, air compressors, and other apparatus not involved directly with drilling.

Any power drive can be operated at full torque, but at reduced speed, despite loss of a complete-engine generator set or component thereof.

These speed-torque characteristics also result in smooth power on draw works or mud pumps regardless of the work load.

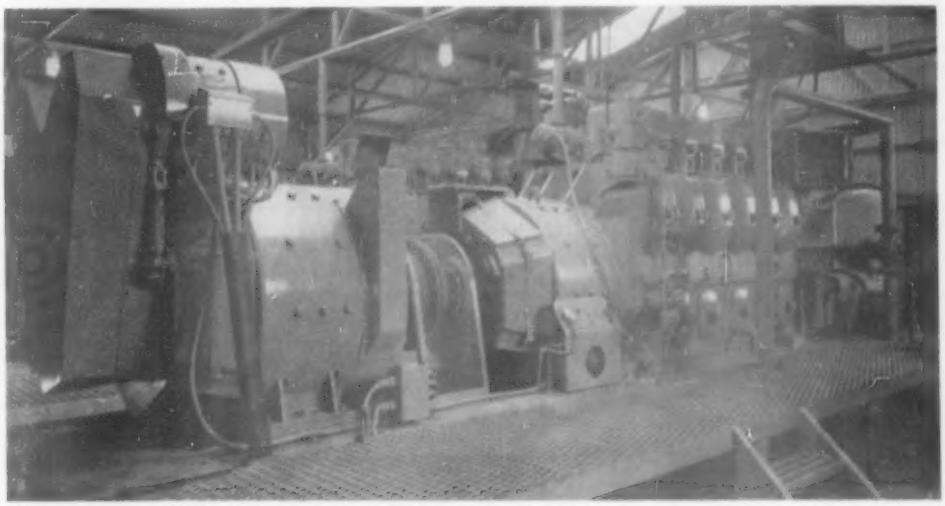
Draw-works motors are mounted in tandem on one skid and are equipped with adaptor kit for mounting of sheave or chain sprocket for equipment drive.

All normal power selections are made by selector-switch power switching. Improper setups are prevented by interlocking.

Flexibility of equipment location makes the use of this diesel-electric power especially adaptable to remote land sites, and particularly to barge, tender, or offshore platform-type rigs where weight distribution and space limitations are so important.

No compounds are required for electric-motor drives. Conversion of existing steam rigs requires practically no mechanical modifications.

The acceptance of diesel-electric equipment in the oil-drilling industry is established because these power packages for drilling rigs are engineered conservatively to avoid mechanical difficulties and to provide efficient power on the job.



ENGINE ROOM and one of the two power packages on Shoreline's offshore drilling barge. At extreme left is auxiliary generator. Next are the 500-kw. main generator and diesel engine. Fig. 3.

Here's REAL Preventive Maintenance

Tidewater calls it the "ideal" program, and it covers everything from design and material controls to quality of personnel

by C. C. Carmine

MAINTENANCE personnel at the Avon, Calif., refinery of Tidewater Oil Co. have formulated the "ideal" preventive maintenance program, and are administering portions of this program successfully.

The first part of this article is devoted to the various factors which make up the ideal program, and the second part is concerned with the phases which have been made effective at Avon.

Scope of Preventive Maintenance

The scope of a preventive-maintenance program includes a consideration of these factors: (1) design and material controls; (2) operating procedures; (3) records; (4) extent of the program; (5) accounting system; (6) organization and procedures; (7) reports; and (8) quality of personnel.

Design and material controls . . . Preventing excessive maintenance begins with design, on the drawing board and at the engineer's desk.

Equipment is selected not only on the basis of first cost; potential operating costs, including maintenance, are given major consideration. Accessibility and handling facilities for performing maintenance are items of importance in laying out new installations.

Design standards and specifications are essential for the guidance of buyer and vendor.

In selecting equipment, provision is made for adequate corrosion and erosion protection.

Standardization and interchangeability of parts are accomplished to the fullest extent.

A storehouse inventory-control system is essential. Such a system includes a complete spare-parts and stock catalog, copies of which are widely distributed and kept current.

During the design stages of an installation, determination is made as to the critical nature of each piece of equipment. Based upon such determination, decision is made at that time concerning provision for spare equipment, spare parts, and inclusion in the preventive maintenance program.

The equipment is located so as to permit its continuous operation under normal loads and its intermittent overloading without probability of breakdown.

Operating procedures . . . Written standard operating instructions are in effect and they provide for the following: (1) starting up; (2) continuous operation; (3) shutting down; (4) lubrication; (5) emergencies; and (6) testing.

Overloading or underloading of equipment is the exception and not the rule.

Instruments and recorded data are constantly observed in order to determine trends, so that steps may be taken to provide minor maintenance and to prevent breakdown.

Where spare equipment is installed, provision is made for alternating operations on a schedule.

Hours of operation and hours of downtime for major equipment are recorded.

Operating personnel agree to the formulation of routine and overhaul preventive maintenance schedules and to adhere to them as closely as possible.

Records . . . An inventory of all equipment in the plant is made and recorded on equipment cards. Each piece of equipment has a separate card, with an identifying inventory or equipment number.

Each card includes the following data: a brief description of the equipment and its service; names of the manufacturer and vendor, or agent; manufacturer's serial number; purchase-order number; work-order number; date of installation; investment cost; drawing numbers for the installation and for the spare-parts list; performance data; and pertinent information on materials of construction.

Space on the card is also provided for recording changes from the original location and service.

Attached to each data card, or closely identified with it, is a maintenance-record card on which is recorded such items as the following: labor and material costs by the month or year; yearly depreciation; inspection schedule; and lubrication schedule.

The maintenance-record card may be used to appraise the amount of maintenance being incurred on a piece of equipment for a short period of time, or the trend over a longer period. The card may provide visual indication of conditions requiring investigation and of possible replacement of equipment incurring excessive maintenance.

Extent of program . . . The next step involves a study to determine what existing equipment is to be placed under the preventive-maintenance program and scheduled for inspection, routine maintenance, and overhaul. Only those items of equipment are included which justify this step economically.

The cost of preventive maintenance for a piece of equipment, or class of equipment, is estimated and compared with the over-all cost in case of a breakdown. The savings in preventing a breakdown are the criterion for inclusion in the program.

In some cases it is less expensive to let a piece of equipment wear out than to include it in a schedule of routine inspection and maintenance.

Accounting system . . . A preventive-maintenace program requires an adequate accounting system which will render current returns on the cost of administering the program and on the cost of maintaining each piece of equipment included in it.

Inventory or equipment code numbers are provided for identifying and recording the cost of maintaining each piece of equipment, either manually or through the use of tabulating machines.

All charges for work performed on any piece of equipment included in the program through the medium of any type of work order or job order are

Author is with Tidewater Oil Co., Avon, Calif. Paper presented at A.P.I. refining division midyear meeting, Montreal, 1956, under the original title, "The Scope and Administration of Preventive Maintenance."

Here's the plant setup . . .

- An integrated, 110,000-bbl. refinery near San Francisco.
- Atmospheric and vacuum distillation, thermal cracking, fluid cat cracking, cat reforming, sulfuric acid alkylation, isomerization, lube oils.
- Twenty-five light and heavy crudes are run.
- Maintenance force is relatively fixed in size.
- Fluid coking will be added soon.

collected against the equipment code numbers and recorded periodically on the maintenance-record card.

Maintenance Organization

The inspection branch of the organization sets up inspection schedules and check lists based on such factors as safety-code requirements, local standards, allowable tolerances, and test results.

The planning and scheduling branch is separate from both inspection and field execution. It operates under a formal written-work-order system. All work to be performed is authorized through the medium of written job orders which are planned in detail and then scheduled through a planning and scheduling system.

Emergencies may be handled by verbal requests, but should subsequently be supported by written orders, and each emergency order should be clearly identified as such, for later review. A preventive-maintenance program is intended to reduce emergencies to a minimum. A periodic review of emergency orders issued affords an opportunity to appraise the justification for emergencies in the different work-authorizing areas.

Reports

The equipment-data card, with its accompanying maintenance-record card mentioned previously, is one currently maintained report which is of great value in keeping track of the preventive-maintenance program.

Types of cost reports having value in currently appraising the program include the following: budgeted vs. actual maintenance costs for the plant and for each facility or cost center; estimated vs. actual costs for maintenance and inspection on standing work orders, and on individual maintenance work orders, including overhauls.

Activity reports include periodic inspection reports on the physical condition of equipment, with recommendations as to what action should be taken. Such a report follows each process-unit shutdown and forms the basis for planning maintenance work to be performed on succeeding shutdowns. Similar reports follow the overhaul of a major piece of equipment, such as compressors, turbines, pumps, motors, etc.

Checkoff lists for routine scheduled inspections include remarks about the condition of equipment. Intermittent inspection reports follow specific requests for investigating the physical condition of equipment not included in an inspection schedule, e.g., buried and aboveground piping, tanks, insulation, electric conduits, fences, wharves, roads, and the like.

A type of report combining both cost and activity would be one following a breakdown. The cost of repairing the facility or equipment which had failed, and the value of production lost as a result of the breakdown, would be determined and evaluated with respect to the type of preventive-maintenace program, if any, in effect.

Quality of Personnel

A training program for both supervisory and nonsupervisory employes is essential.

In our preventive-maintenance program we want trained supervisors, inspectors, engineers, and mechanics.

Inspectors may or may not be technical men, but they certainly should have had abundant field experience and should be trained in being objective and accurate in their observations and in the art of writing factual and concise reports. They should know the design and the functions of the equipment which they are assigned to inspect.

The engineer, the man trained in the "scientific approach," is an essential element in setting up and administering a preventive-maintenance program.[3] After the studies are conducted, schedules made, and written procedures established, the record keeping may be turned over to the clerical force, the inspection to the inspectors, and the maintenance to the mechanics.

Preventive maintenance—any maintenance—needs engineers to help make it effective. Engineers with practical field experience are preferred. The engineer with limited field experience is, however, acceptable.

The engineer is needed in our preventive-maintenance program for such activities as setting up the system of record keeping; establishing inspection and lubrication schedules; determining the critical equipment and spare parts to be carried; formulating a satisfactory planning and scheduling system, with the written work order as its basis; developing an inventory-control system; writing procedures; appraising performance with respect to design; diagnosing equipment failures; studying job methods; assisting in a standardization program; and reviewing material handling methods and equipment.

Tidewater's Avon Refinery

Tidewater's refinery in Avon (approximately 30 miles east of San Francisco) has, at the present time, a crude-oil throughput capacity of 110,000 bbl. per day.

It is an integrated oil refinery with the following major facilities: atmospheric and vacuum distillation; thermal cracking; fluid catalytic cracking; catalytic reforming; sulfuric acid alkylation; isomerization; light and lubricating-oil rerunning and treating; receiving and shipping by pipelines, vessels, tank cars, and tank trucks; and tank-farm storage.

Fluid-coking facilities are to be added in the near future. Twenty-five different kinds of light and heavy crude oils are run, with sulfur content ranging up to 7 per cent.

The maintenance force is relatively fixed in size and is augmented, for peak-maintenance load conditions during shutdowns of the very large units, through outside contractors.

The refinery is divided geographically into three maintenance zones.

The maintenance organization is responsible for the field planning and execution of maintenance and construction work which it is authorized to perform. It is also responsible for liaison with outside contractors when they are employed to augment our own maintenance force. The organization is headed by the supervisor of maintenance and construction, with the following four subdivisions:

1. Field execution: This includes

zone and craft personnel who perform authorized field and shop work in accordance with detailed job plans and a written daily work schedule.

2. Daily planning: This includes zone planners and central-planning-office personnel who formally plan zone maintenance work and schedule all work on a daily basis.

3. Project planning: This includes project planners in the zones and project-planning office who plan and schedule major process-unit shutdowns, plus maintenance and construction projects which are to be performed by our own maintenance force and require top-management approval.

4. Office: This includes clerks and typists who perform all of the department's clerical work.

It will be noted that execution and planning of work are separate functions. It is our considered opinion, after 5 years' experience, that this separation is essential.

Avon's Preventive Maintenance

The refinery has an indepent **plant-inspection group.** It has two main functions: (1) the nondestructive inspection of existing static structures for conformance to safety-code requirements, for evidences of corrosion or erosion, for indications of fatigue, and for general physical condition; and (2) the inspection of new installations for adherence to design standards and specifications.

Extensive use is made of approved techniques and tools of inspection,[4] including visual inspection, mechanical calibration, pressure tests, corrosion buttons, trepanning, safety drilling, X-ray and supersonic instruments, fluorescent penetrant inspection, vacuum-seam testing, magnetic-particle inspection, and pipeline-leak detectors.

This group keeps written records of measurements and conditions found in connection with scheduled and unscheduled inspections made on pipelines, furnaces, towers, vessels, tanks, wharves, buildings, fences, power and lighting pole structures, condenser boxes, cooling towers, and heat exchangers. It maintains schedules of required inspections of pressure vessels to be made in accordance with safety codes.

During a process-unit shutdown it inspects all portions of the facility made available by the operating personnel. Complete records are kept of such inspections, and recommendations are made for further inspections and for repairs to be made on succeeding shutdowns.

Inspections of other facilities, reports, and recommendations are also made in connection with: (1) inspection schedules (pressure vessels, for example); (2) specific requests (buildings, fences, pole structures, wharves); (3) accident or equipment failures (pipeline breaks, wharf damage, vehicle accidents, tank leaks); or, (4) routine operations (changing services of tanks).

Shutdown scheduling . . . Process-unit shutdowns are scheduled for 12 months in advance and are revised periodically. These schedules are made up for all major process units; they provide for optimum lengths of run based on conditions reported by the plant-inspection group, on production commitments, and on the desirability of maintaining a reasonably steady work load for the maintenance and construction department.

Rotating machinery . . . The portion of the program pertaining to pumps, turbines, gas engines, blowers, fans, and compressors is administered by a machinery inspector assigned to the project-planning group of the maintenance and construction department.

A study was made of this equipment, in cooperation with operating personnel and the mechanical crafts; critical items of equipment were determined; a system of equipment-record cards was set up; written maintenance procedures were issued; and schedules were established for inspection, routine maintenance, and overhauls.

The machinery inspector plans, in detail, the overhaul of the larger equipment, such as gas engines and compressors, and acts as trouble shooter on maintenance and operating problems involving the equipment under his inspection jurisdiction. He diagnoses equipment failures and makes reports and recommendations for corrective measures, replacements, changes in operating and maintenance procedures, and alterations in design. He assists with the standardization program involving the selection of equipment and interchangeability of parts.

The schedules for routine daily, weekly, and monthly inspections and for minor maintenance work are carried out by the small group of mechanics, assigned permanently to the three maintenance zones, who report results on written check-off lists.

Repairs performed on overhauls are also reported by the mechanics performing the work on written check-off lists. These checkoff lists are forwarded to the machinery inspector; he has the pertinent information recorded by a clerk on equipment-record cards which are kept in the central planning office.

Electrical equipment . . . Preventive-maintenance for motors and other electrical equipment has been developed by the general foreman of the electric shop and is administered by him in conjunction with certain planning functions of the maintenance and construction department.

Equipment records for motors, starters, and controllers are maintained by a clerk in the electric shop.

Motor servicing is handled through a tickler file system maintained in each of the three zone offices. At the beginning of each year a job order is issued by the electric shop to each of the zone offices for the servicing of motors in the zone. A schedule, listing by weeks the motors which are to be serviced in the zone during the year, is attached to each job order.

The clerk in the zone office, through the medium of his "tickler" file, advises the zone planner each week of the motors which are to be serviced the following week. It is then the responsibility of the zone planner to

. . . and here's how planning and scheduling are performed

- Planning is separated from field work.
- Work orders are written to zone or planning office.
- Each job is estimated to nearest hour.
- Three classes of priority are assigned.
- Blanket job orders are supported by written schedules.
- Manpower required is balanced daily against requirements.
- A daily work schedule is issued on preceding day.
- Central planning office handles manpower and schedules.
- Weekly work schedule is issued for major jobs.
- Major shutdowns are planned well in advance.
- Emergency jobs are kept to a minimum.

provide, on the daily work schedule during the following week, the manpower to complete the servicing of motors specified for that week on the annual motor-servicing schedule.

The record of motor servicing performed is entered on a card by the mechanic who did the work and is forwarded to the electric shop for transfer to the permanent equipment records.

Motor-bearing oiling is performed on a weekly schedule by one mechanic from the electric shop.

Other items of electrical equipment inspected and maintained by electric-shop personnel on the basis of established schedules are: diesel-electric locomotives, fork-lift trucks, synchronous motors, and the Cottrell precipitator.

Servicing of elevators is performed on a preventive-maintenance schedule by an outside contractor specializing in this type of operation.

Checking for grounded circuits is performed on a routine schedule by electricians on the afternoon and graveyard shifts.

Instruments and Controls

Preventive-maintenance on instruments and controls is administered by the instrument shop. The policy has been to concentrate responsibility for the inspection and maintenance of all instruments and controls in one craft, whether they are mechanically, electrically, or electronically operated.

Equipment records are being kept on relief and control valves. The valves are serviced, where possible, on schedules accompanied by checkoff lists. Attempt is made to check and test all relief valves once a year. Records have been set up for relief valves, reflecting details of design, metallurgy, and spare parts. Where maintenance costs appear excessive on the record cards, investigation is conducted as to the desirability of changes in selection, design, or metallurgy.

Servicing of indicating gages, thermometers, pyrometers, meters, controllers, transmitters, and vapor-recovery equipment is conducted in the field through the medium of blanket job orders for a definite period of time, supported where possible by written schedules and checkoff lists.

Automotive vehicles . . . The refinery has 130 automotive vehicles including passenger cars, pickups, dump trucks, flat-bed trucks, heavy construction equipment, and six service trucks belonging to the marketing department. All of these vehicles are serviced on established written preventive-maintenance schedules based upon mileage or hours of operation.

Planning and Scheduling

The refinery has a formal planning and scheduling system based upon the following general principles:

1. Planning is spearated from field execution.

2. Work is authorized through the medium of individual job orders written by operating or facility supervisors to three zone offices, for jobs whose aggregate cost is estimated to be less than $1,000; or to a project planning office, for jobs costing $1,000 or more.

3. Each job order is planned and estimated to the nearest hour by a planner, in terms of: (a) man-hours by crafts; (b) craft sequence; (c) material required; (d) priority; (e) date available; (f) date to be planned; (g) date to be completed; (h) scope of the work, with drawings and sketches attached; and (i) safety and fire-prevention measures to be taken.

4. Priorities are of three classes: (a) emergency; (b) priority No. 1; and, (c) priority No. 2. Emergency jobs are those which cannot wait for formal planning procedures and which cause an interruption in the work as planned.

Priority No. 1 jobs are those formally planned, which are to be completed by the date listed on the job order. Priority No. 2 jobs are also formally planned, but permit completion dates to be arranged on the basis of available manpower or material and prior work commitments.

5. Blanket job orders, issued for a definite period of time to make a preventive-maintenance program effective, are supported by written schedules and checkoff lists wherever possible.

6. Manpower required is balanced daily against manpower available in the various crafts.

7. A written daily work schedule is issued to the entire maintenance and construction department for work to be performed on the following day. This schedule lists all current jobs by zones and by crafts, with the estimated number of men and hours required for each job.

8. The daily balancing of manpower and preparation of a daily work schedule are performed in a central planning office which is the heart of the entire planning and scheduling system.

9. A weekly project work schedule is issued by a project-planning office on Thursday of each week, for the major maintenance and construction projects, including process-unit shutdowns, to be performed during the following week. This schedule serves as a target for the central planning office, which does the daily scheduling of all work, in dovetailing the project jobs with the zone maintenance jobs.

10. Process-unit shutdowns are planned 3 to 4 weeks in advance of the shutdown, except in the case of the fluid catalytic cracker where planning starts at least 6 months ahead.

11. An attempt is made to keep emergency jobs to a minimum. In terms of job orders, the target for the maximum number of emergencies is on the order of 10 per cent. This represents about 3 per cent of the total man-hours.

Personnel . . . The refinery has a training program for the training of mechanics, inspectors, and operators. Jointly administered by management and the union, it has been included in the labor agreement for the past 12 years. Both parties may be justly proud of the manner in which the program has functioned over this period of time.

Assigning of engineers to the maintenance ranks for field training has been inaugurated during recent years. Maintenance functions having to do with such activities as inspectors, planning, scheduling, methods improvement, and material handling are being examined more and more in terms of what the engineer can do to set up and administer a program in which they are included.

The Future

Business-machine accounting is soon to be applied to inventory control. It is anticipated that the existing application of mechanization to maintenance accounting will be widely extended and will assist considerably in the further development of the preventive-maintenance program in particular and maintenance activities in general.

Many studies are being conducted for such purposes as: improving the present organization and procedures, establishing a complete list of critical equipment and spare parts, developing more extensive schedules, setting up an adequate record-keeping system and providing for the proper number and kinds of management-control reports.

The refinery is engaged in an extensive expansion program. Provisions for preventive-maintenance is an essential part of that program and is being developed concurrently with the construction of new facilities.

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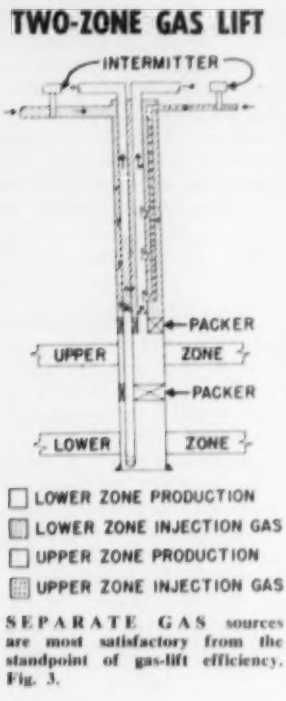
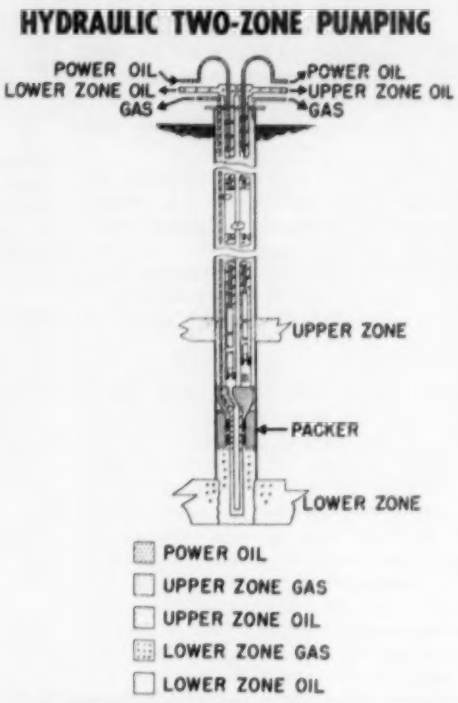


SEPARATE GAS sources are most satisfactory from the standpoint of gas-lift efficiency. Fig. 3.



FLEXIBILITY of hydraulic pumping is provided by independent power-oil strings. Venting of gas from both zones improves pump performance. Fig. 4.

Casing size, depth, type of drive, productivity of both zones and characteristics of the produced fluids all should be considered when a dual-zone well must be artificially lifted. Seldom will a free choice of methods be possible. This article discusses the merits and applications of available methods.

by J. Zaba, Henry Schaefer, and George E. O'Neal

Part 2

What you ought to know about

Producing Dually Completed Wells

VERY seldom is a free choice available for the selection of the method of artificial lifting which would be most efficient for any given dual well. There are so many limiting factors which enter into consideration that, with the equipment now available, compromises must frequently be made.

...Size of the casing is probably the most important of these factors. Even the most prudent operator may be faced with necessity of artificially lifting a dual well completed with 5½-in. casing. This may happen when the second zone was not expected to be productive on a given location and drilling of a twin well is not economically justified. Or the situation may exist when the dual production is expected, but the prospects of recoveries are so marginal that only most rigid economies justify drilling of a well which would have a chance of a reasonable return on investment. The small size of casing automatically eliminates from consideration methods which may be most efficient under given well and field conditions.

...Other factors which may have conflicting effects on the selection of the methods are: the depth of the zones and the interval between them; the type of reservoir drive under which each of the two zones is producing; the productivity of the two zones, and the magnitude of these productivities in relation to each other; the characteristics of the produced fluids such as forming of paraffin, scaling, and corrosion. Field conditions may also have a marked effect, such as: availability of service for the type of equipment used, the degree of isolation of a given location, climatic conditions, type of power available, and others.

The magnitude of the effect these factors have on the selection depends upon the method to be used. For instance, in case of intermittent gas lift, the paraffin-forming characteristics may be the controlling factor. With subsurface reciprocating pumps, either sucker-rod or hydraulic, the ability to vent the gas of the two zones to assure reasonable pump efficiencies may be of primary importance.

The foregoing considerations are given here to emphasize two facts: **First** that the design of an artificial-lift installation for a dual well is in each case an individual problem; **second,** that in a predominant majority of cases the resulting installation is only an approach to what would be desirable from the point of view of efficiency, sound engineering, and economy of artificial lifting.

Gas Lift

Attention should be called to the frequently encountered misstatement about a dually gas-lifted well when one of the zones is still flowing and the other is being gas-lifted. This arrangement is not difficult and may be

The authors are with Stanolind Oil & Gas Co., Tulsa. Paper presented at A.P.I. Division of Production, Mid-Continent District, meeting at Wichita, under the original title, "Producing Dually Completed Wells."

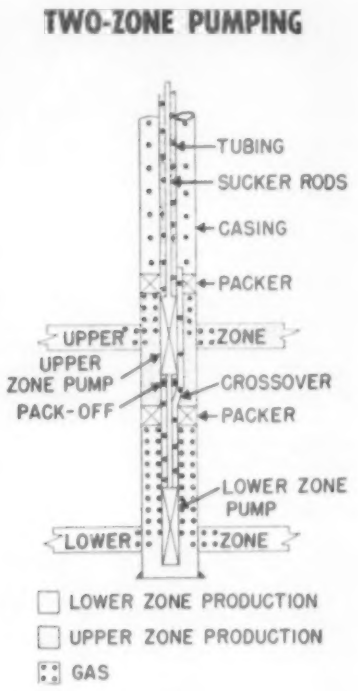


Fig. 5

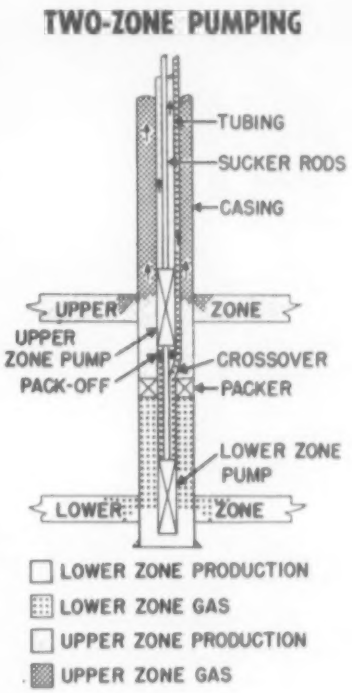


Fig. 6

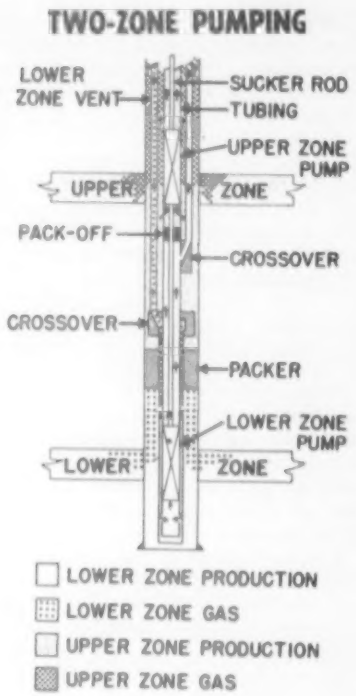


Fig. 7

TANDEM ROD PUMPS can produce dual zones at a minimum investment. Only one string of rods and one power unit is necessary. Systems can be installed in 5½-in. casing.

highly efficient. But it does not represent, in true meaning of the word, a dual gas-lift installation.

There exists a very large number of possible types of gas-lift installations for dual wells. This is understandable when one considers different possible combinations of following conditions and arrangements:

1. From the point of view of method of operation, either one or both zones may have to be produced either continuously or intermittently.

2. The valves may be any combination of differential, pressure-actuated, or pressure and fluid-actuated valves. They may be integrally installed in tubing strings or they may be of the wire-line-retrievable type.

3. The eductors may be used in concentric, parallel, or combination concentric and parrallel arrangements.

4. Different combinations of annular or tubing flow may be used.

5. The source of operating-gas supply may be the same for both zones or each of the zones may have its own source of supply.

Considerations . . . It is beyond the scope of this paper to go into details of these different arrangements, particularly since many of them have been already described in the technical literature. Instead, a general line of thought is presented which should be followed in considering a gas lift as a method of production for a given dual well:

1. Modern gas lift is a highly flexible and efficient method of production. However, supervision by personnel familiar with gas-lift practices is an essentail prerequisite for satisfactory operation of gas-lift installations. Therefore, the availability of properly trained personnel should always be considered in any preliminary appraisal of gas-lift possibilities.

2. Unless both high-pressure gas and a market for low-pressure gas are available, rotative gas lift requiring compression horsepower will be needed. As soon as gas pressure and volume requirements are available, cost estimates can be made using a figure of from $200 to $275 per connected horsepower, depending upon size and type of compressors used. This will give comparison of investment cost for gas lift against other methods of artificial lift.

3. The productivity of the two zones determines whether continuous or intermittent lift will have to be used. The productivity of the lower zone and the interval between the zones may materially affect the complexity of the subsurface equipment needed.

In selecting arrangement and sizes of eductors, the following broad principles should be considered:

1. Of the arrangements now being used, the most satisfactory one, from the point of view of gas-lift efficiency, consists of two strings of 2⅜-in. tubing with separate sources of operating gas for each of the two zones. One such arrangement is shown in Fig. 3, with gas for the lower zone being supplied from the casing annulus and gas for the upper zone supplied through a small tubing attached to the 2⅜-in. tubing.

2. The size of casing may eliminate possibility of use of the parallel strings of 2⅜-in. tubing. Use of small tubing may be then considered within following limitations: (a) little information is available on the multiphase flow through vertical small tubing; however, the need for high injection pressures may be expected; (b) if the large casing annulus is the common source of gas supply, high input ratios in intermittent flow may be expected. In continuous flow, the size of valve ports is very critical.

3. Concentric tubing - string installations are less expensive than those using parallel strings. Their installation is simple and they are adaptable to small casing diameters. They do have, however, definite limitations as follows: (a) frictional losses in the annulus between large and small tubing are high if gas is injected through this passage; (b) the intermittent flow through tubing annulus is inefficient.

4. More than in other methods of production, the question of paraffin

deposition should be carefully considered. Intermittent gas lift is conducive to formation of paraffin because of alternate wetting and drying of the walls of the eductor.

5. If intermittent gas lift is to be used and one source of operating-gas supply for both zones is considered, the valve interference becomes a problem. Use of properly selected pressure and fluid-actuated valves appears to be a possible solution.

Free piston . . . The purpose of the free piston is to increase the efficiency of the intermittent gas-lift operations by interposing a solid interface between the injected gas and the lifted fluid. This reduces the backflow of oil and the channeling of gas. If two parallel strings of 2⅜-in. tubing are used, the free piston can be used successfully for intermittent operations.

The free piston is also being used, under certain well conditions, to prolong the flowing life of wells. In this application, the well's own gas is used without injection of outside high-pressure gas. Because the requirement for such an arrangement is accumulation of gas between the cycles in a relatively large casing annulus, it is of interest to note that a free piston was used successfully to flow the subpacker zone of a dual well in West Texas with the lower packer only 600 ft. from the bottom of the well.

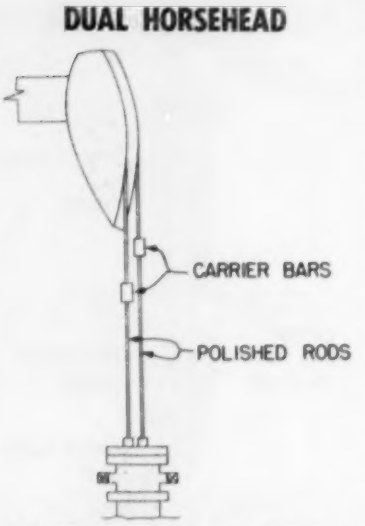
Prior to installation of the free piston, the lower zone of this well was flowing by heads 27 bbl. of oil per day with an average gas-oil ratio of 2,745 and was about to be placed on pump because of the need for frequent swabbing to restore the flow. The well operated for 6 months with a free piston; and immediately before the installation was pulled for workover of the well, the lower zone was still producing 24 bbl. of oil and 14 bbl. of water per day on regular intermitting cycles with an average gas-fluid ratio of 2,620.

Hydraulic Pumping

Three arrangements for hydraulic pumping are considered, although others are available for alternate production of the two zones.

Fig. 4 illustrates an arrangement consisting essentially of two independent hydraulic-pumping systems. Complete flexibility, venting of gas from both zones and means for handling paraffin are offered. The arrangement requires five strings of tubing, three of which are parallel, the other two being concentric.

Of the other two systems offered, one employs one string of 2⅜ or 2⅞-in. tubing with two strings of small tubing clamped to it. A hydraulic subsurface unit is run on small tubing inside of large tubing with two pumps in tandem. Inasmuch as each of the two pumps has an independent source of power oil, their speed may be varied to fit the production characteristics of each of the zones.



TWO ROD STRINGS operated from this dual horsehead provide more flexibility than two-zone pumps on one string. Fig. 8.

In the other arrangement, two free pumps, rigidly connected, are set in the large tubing. Power oil is supplied to both pumps by small tubing clamped to the large string. The speed of each of the pumps is regulated by back pressure on the flow line of the corresponding zone. One zone is produced through the annulus and the other through the large tubing. No gas vent is provided for either of the zones. The installation may be used in 5½-in. casing.

Sucker-Rod Pumping

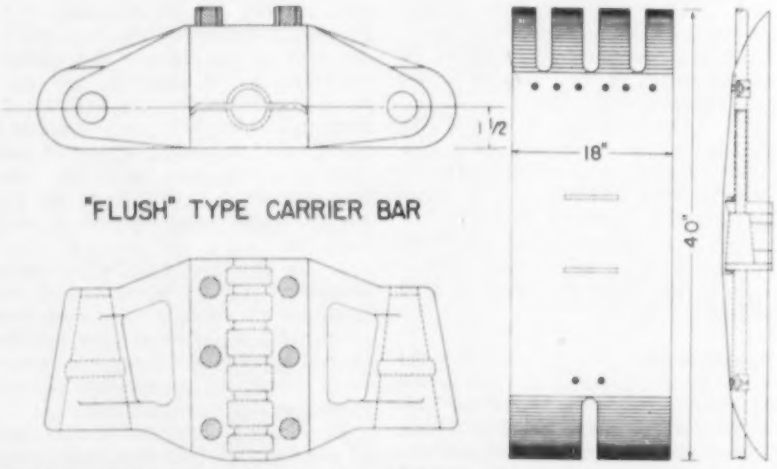
Three sucker-rod pumping methods are used for pumping dually completed wells. These methods utilize: (1) the so-called "two-zone pumps"; (2) one pumping unit with a special "dual" horsehead and two independent subsurface sucker-rod systems; and (3) two entirely independent sucker-rod pumping systems.

Two-zone pumps . . . This method uses one pumping unit and one string of rods to actuate two subsurface pumps arranged in tandem. The commingling of the fluids of the two zones is prevented by suitable packers, crossovers, and by a packoff of the rod connecting the two pumps. Details of pumps and of manner of setting them differ depending upon make. Figs. 5, 6, and 7 show schematically the arrangements of the two-zone pumps most commonly used.

In the method illustrated in Fig. 5, two packers are used with a crossover between the packers. The lower zone is pumped by the lower pump through the crossover into the casing annulus. The upper zone is pumped by the upper pump through the tubing. Fig. 6 shows the method in which the crossover discharges into a string of small tubing attached to the large tubing, instead of into the annulus. Only one packer is used. In Fig. 7, a second small string is added to vent the gas of the sub-packer zone.

The advantage of dual-zone pumping is the relatively low investment cost in comparison with other methods. Also the method may be used in 5½-in. casing.

The principal disadvantage is lack of flexibility. Only the pump size can be varied because the length of stroke and the speed of pumping are the same for both zones. A marked difference between productivities of the two



DUAL PUMPING UNITS provide each zone with a set of rods and separate power unit. This carrier bar and shield allows units to work on the same level a distance of 3.9 in. between the center lines of the tubing strings. Fig. 9.

Sunday Outing...

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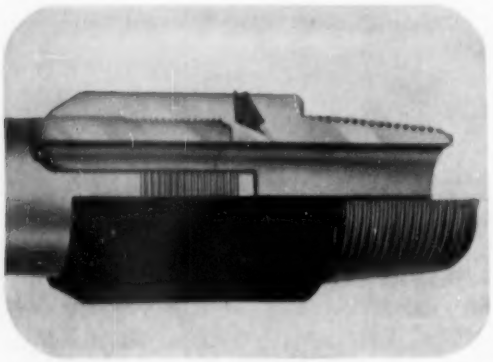

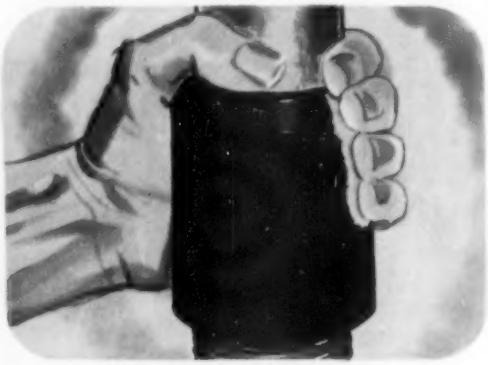

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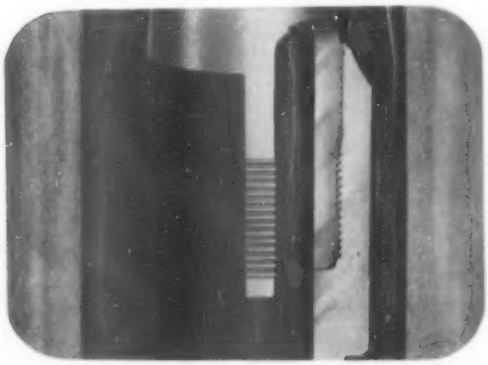

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Write for Bulletin DC505. This bulletin will give you specifications, dimensions, weights, torque tables and other drill collar pipe data. The book also contains pointers on care and maintenance.

zones may lead to serious operating difficulties resulting in high operating cost. Fluid pound in one pumped-off zone may bring about frequent rod breaks when an attempt is made to produce the allowable of the other zone. The same is true for pounding caused by gas locking. The whole assembly must be removed on each pulling job. If the upper zone produces sand, serious pulling difficulties are a possibility. The allowable stresses of commercially available sucker rods impose on the method certain depth and volume limitations.

Dual horsehead . . . In this method, one pumping unit with a special "dual" horsehead operates two subsurface pumps placed in two parallel strings of 2-in. tubing. Fig. 8 shows the details of the special horsehead. The cost of conversion of a conventional horsehead of an A.P.I. 228 pumping unit is about $400.

Dual pumping units . . . In this method, each of the two zones has its own independent sucker-rod pumping system consisting of a pumping unit, a string of rods, a string of tubing, and a subsurface pump.

The problem in such an installation is the clearances between different elements of the surface equipment. For instance, with a conventional 7-in. dual tubing head and 2⅜-in. E.U.E. tubing, the distance between center lines of tubing strings is about 3 9/16-in. This does not leave any clearance between carrier bars of the two polished rods and between the tubing of one zone and stuffing box of the other zone.

In the installation of this system made in southern Oklahoma in June 1954, the problem was solved, first by elevating one of the units so that the carrier bars did not pass each other; and second, taking of 3/16-in. off the stuffing-box cap so that a clearance of 1/16-in. was obtained.

Later, as the number of this type of installations increased and larger units had to be used, the cost of elevating one unit became a factor. The units were then placed on the same level but following modifications were made:

1. A special dual tubing head was designed and built in which the distance between the center lines of the two tubing strings was increased to 3.9-in.

2. Special combination carrier bars were designed and built (Fig. 9).

3. These two modifications permitted a clearance of 0.9-in. between the carrier bars. As a safety measure, a special shield was designed and built. (Fig. 9.) This shield, bolted over the carrier bar, prevents the bars from locking in case they swing together. The shock resulting from the carrier bar striking the shield would actuate the beam safety switches shutting down the units.

4. In certain installations, two top joints of 7-in. were backed off and replaced with 9⅝-in. casing. A conventional 9⅝-in. dual tubing head furnishes a clearance of 1⅞-in. between the carrier bars.

Most flexible . . . The method offers complete flexibility of a conventional single-zone sucker-rod pumping installation. It is limited to 7-in. casing or larger, although work is now done on special integral-joint tubing having 2 1/16-in. outside diameter and 1.75-in. inside diameter. This tubing should permit use of ¾-in. rods with ⅝-in. couplings. Two strings of such tubing could be used in 5½-in. casing.

The cost of dual-pumping unit installation is higher than that of other dual sucker-rod systems. However, in a number of cases, this cost is paid out from increased production and reduced operating expense, as illustrated by following example.

A well in southern Oklahoma was operating over a period of 2 years on a two-zone pump. Because of highly divergent producing characteristics, the operating difficulties, already discussed, resulted in pulling costs averaging $175 per month. The installation was replaced by a dual-unit system with a resulting decrease in pulling costs to $20 per month for the 18-month period. This saving alone would have paid out the difference in cost of the two installations in 48 months. However, the ability to adapt pumping-cycle characteristics to the producing characteristics of the two zones resulted also in substantial increases in production despite reduction in pump size and speed of pumping of one zone as shown as follows:

	Two-zone pump	Dual units
Upper zone		
Pump size, in.	1⅝	1½
Stroke length, in., and speed, s.p.m.	54-16	24-14
Average production, bbl. per day	10.8	42.6
Lower zone		
Pump size, in.	1¾	1½
Stroke length, in., and speed, s.p.m.	54-16	24-14
Average production, bbl. per day	51.3	*39.2

*Normal decline in production capacity.

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BACK-PRESSURE REGULATOR

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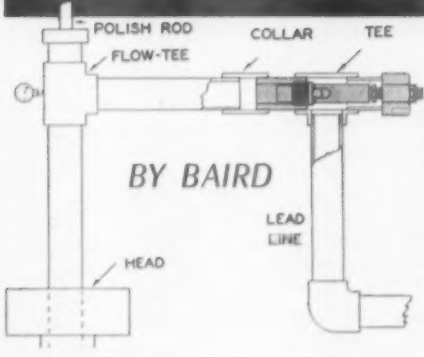

Keeps pressure on tubing strings.

For wells that head up and flow, back pressure on the tubing tends to keep the tubing full which prevents stuffing box trouble and increases pump efficiency. By maintaining a back pressure on the tubing, this regulator keeps gas from breaking out of the solution and thus helps to prevent paraffin formation.

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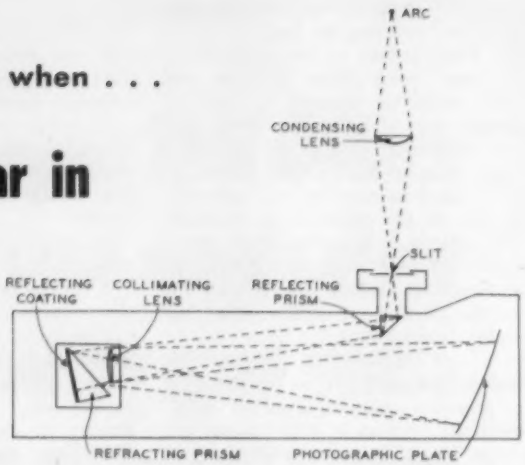
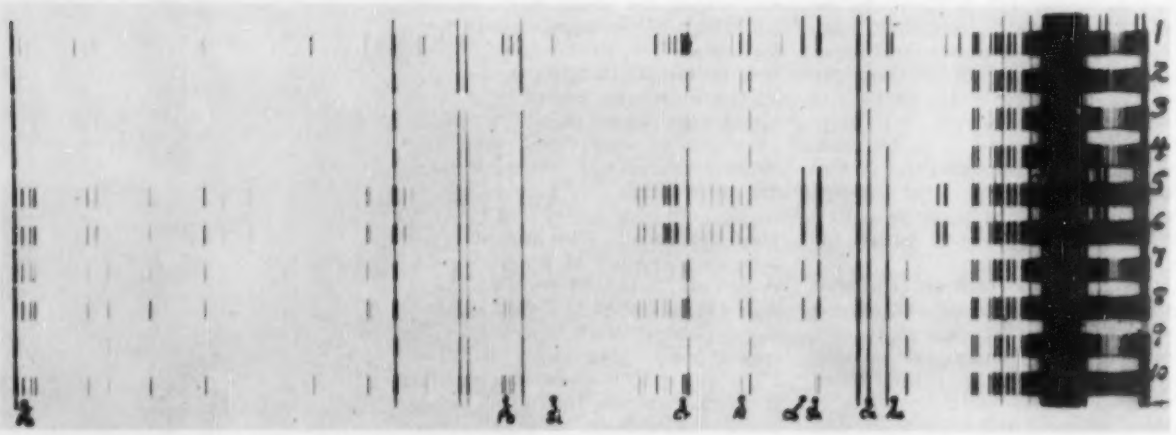
Lubricating Oil Reveals Wear in Pipeline Compressors

by J. L. Wilson and S. R. Sawyer





SPECTROGRAPH uses electric arc, Fig. 1, top, and optic system to break oil sample into components. The spectra lines are then recorded on film such as in the plate shown in Fig. 2, immediately above. Each metal present in sample can be identified from position of characteristic wave length in the spectrum.

The use of spectrographic analysis of compressor lubricating oil promises to be an important maintenance tool for gas pipeline operators. This article is a progress report on an A.G.A. research project on the method.

A SATISFACTORY method of measuring wear and of detecting parts failures before they cause breakdown in pipeline engines and compressors, without removing the engines from service, would be of great value to the natural-gas pipeline industry. Research project NB-16 of the American Gas Association is designed to evaluate the use of spectrographic analysis of used lubricating oils as a tool toward this end. Although not completed, the project indicates that this type of analysis shows possibilities of indicating changes of wear rate and of detecting parts failures in pipeline engines.

Authors are with Texas Gas Transmission Corp., Owensboro, Ky., and El Paso Natural Gas Co., El Paso, Tex., respectively. Paper presented at Eleventh Annual Short Course in Gas Technology, Texas A. & I. College, Kingsville, June 1, 1956.

The engine lubricating oil seemed to afford the most promising line of study since it contacts all moving parts which are subject to wear and removes the products of wear. Analysis and identification of these wear products and contaminants in the used oil can be used to furnish information on general wear and also on wear regarding specific parts.

These wear products are very slightly soluble in the oil and are generally present in such small amounts that standard methods of chemical analysis can be immediately discarded. The tremendous oil sample size necessary to obtain enough residual contaminant to analyze precludes the use of the gravimetric or volumetric methods of analysis. The use of radioactive parts to study wear is relatively new and no standards exist for the comparison of results. Some experimentation has been done along this line with small engines, but the very size of compressor-engine parts, the limited radioactive sources for activating the parts, and the special handling techniques required for this method make it unfeasible at the present time.

The emission spectrograph is the most feasible of the instrumental methods in that it requires a small sample and is sensitive in detecting trace amounts of metals and metal compounds in a wide variety of materials. The analytical techniques for using this instrument have been worked out and standards for comparison are known. The pioneer work by the railroad industry, in applying this method to locomotives, has furnished a background of experience in interpreting results of this method on engines which closely parallel compressor engines in size and operation.

The spectrograph . . . The emission spectrograph, Fig. 1, is an optical instrument whereby a sample of material to be analyzed is vaporized by an electric arc between two electrodes. The radiation produced is confined to definite wave lengths in the ultraviolet range. The radiation, or light, is focused through a condensing lens on a slit ranging from 10 to 200 μ wide. The light is then dispersed into its individual wave lengths using a refracting prism or a diffraction grating, and then focused on a photographic plate where the spectrum appears as a series of lines as shown in Fig. 2.

Each line is an image of the slit and represents a wave length present in the original source. Each element has several characteristic wave lengths by which the element may be identified. With proper choice and control of the exciting energy, slit width, and exposure time the density (blackening) of the images on the photographic plate is proportional to the concentration of the elements in the sample.[1]

Project NB-16 . . . Eleven of the major gas-transmission companies are participating in the program, and a total of 75 compressor engines are being tested. These engines are representative of the makes and types of engines in general use. Several special engines were also included because they may be forerunners to a future trend in compressor engines. These include a vapor-phase cooled engine on the United Gas system, Nordberg engine on Transcontinental's system, and some of the turbocharged and converted turbocharged engines on the Natural Gas Pipeline and Tennessee Gas systems.

A sample of lubricating oil from each engine is taken monthly and sent to the Institute of Gas Technology where it is analyzed spectrographically. Information regarding the operating histories of each engine, general conditions of repair, wear records where available, materials of construction, and oil-filtration equipment used was compiled and forwarded to the institute at the start of the program. Pertinent operating data regarding unusual weather conditions, oil-filter changes, and repair work performed is sent to the institute each month from each engine on test.

Metals Used as Wear Indicators

The oil samples are analyzed for eight metals: silicon, iron, chromium, aluminum, copper, lead, tin, and boron. Two physical tests, pentane insolubles (A.S.T.M. D-893), and neutralization number (A.S.T.M. D-974), are also run on each sample. These metals, separately and in various combinations, are used as indicators for wear in the various parts of the engine. The physical tests are run with the feeling that some correlation exists between the spectrograph results and physical results.

Silicon is generally considered to be the best indicator of dirt and particularly air-borne dirt. The principal source of dirt in compressor engines is the combustion air supplied to the engine. The quantity usually depends upon the degree of air-filter maintenance.

Iron is an indicator for unusual wear conditions in almost any part of an engine. Iron can indicate excessive wear of rings, pistons, cylinders, crankshaft journals, gears, and other parts. Therefore a combination of elements must be used to pin point the source of the iron and part that is wearing.

Chromium is an indicator for several sources of trouble. Many engines use chrome plated liners or piston rings, and chromates are commonly used to treat the cooling water. If a water leak into the crankcase develops, the water evaporates leaving the chromate.

Aluminum indicates bearing wear on engines with aluminum bearings.

Copper, being a constituent of most bronzes, brasses, and babbitts, is an indicator for wrist-pin, bearing, and ring wear where bronze rings are used.

Lead and tin are indicators for bearing wear since they are constituents of the tin-base babbitt normally used as bearing metal for compressor engines.

Combinations of wear elements . . . Combinations of elements must frequently be looked for to determine or predict conditions within an engine. A knowledge of the various materials used in an engine is also necessary for a correct interpretation of wear conditions in an engine. For example, a high iron content alone could indicate excessive wear in the power cylinder area provided the cylinders, pistons, and rings were iron and not plated with some other metal. If chrome rings or chrome plated cylinders were used, then a high chrome content would be expected in a combination with the high iron content.

If the high iron content is due to excessive ring wear, there is usually blowby into the crankcase of combustion gases. The best indicator for blowby is the pentane-insoluble test. The pentane-insoluble test is not usually taken into account in interpreting unless the value is high. High iron in combination with high tin and lead would possibly indicate excessive crankshaft wear due to bearing trouble.

The tabulations of analyses which follow will best demonstrate how the various metals alone and in combination have been used to correlate wear conditions and failures in compressor engines with spectrographic analysis results. These and the other data in this paper are taken from engines on test in the pipeline research program and from engines on the Texas Gas Transmission Corp. system. Texas Gas began experimenting with this method in 1954 and its backlog of information and interpretive experience has been helpful to the present program.

TABLE 1—SPECTROGRAPHIC ANALYSES SHOWING NORMAL ENGINE OPERATION

	Metal content, p.p.m.						
	1954					1955	
	May	July	Aug.	Oct.	Dec.	Feb.	Apr.
Pentane insoluble	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silicon	2	1	3	1	1	1	3
Iron	2	1	1	1	2	1	7
Tin	1	1	1	2	2	1	1
Aluminum	1	1	1	1	3	1	1
Copper	4	1	1	1	1	1	1
Lead	5	1	1	1	1	1	2

TABLE 2—SPECTROGRAPHIC ANALYSES SHOWING RING AND CYLINDER WEAR

	Metal content, p.p.m.						
	1955			1956			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Pentane insoluble	0.02	0.01	0.00	0.05	0.01	0.00	0.00
Neut. number	0.1	0.3	0.2	0.3	0.3	0.9	1.1
Silicon	1	1	1	7	7	4	3
Iron	2	6	15	59	64	36	20
Chromium	1	1	1	1	1	1	1
Aluminum	1	1	1	1	1	1	1
Copper	1	1	1	3	3	3	2
Lead	1	1	1	2	2	2	3
Tin	1	1	1	3	4	4	4

Test Results

Normal engine . . . The group of analyses in Table 1 is from an engine in which operation is normal. This engine is lubricated with nondetergent naphthene-base oil and is equipped with a bypass fuller's-earth-type filter. During the period shown it operated at an average load of 90 per cent.

These analyses in Table 1 cover a

period of a year. This particular engine was overhauled just before the first sampling in April 1954 and again in April 1955. At that time new type power pistons and aluminum main bearings were installed. These changes were made not because of excessive wear but because of a decision to standardize on these new parts. Measurements did not show appreciable wear in any part of the engine.

Some of the variations among the individual analyses are due to the addition of quantities of fresh oil to the crankcase. About 200 hours of operation are required after an oil change until the analyses begin showing stable values again. Filter changes, particularly if earth-type filters are used, have a tendency to distort the analyses.

Table 1 then emphasizes what is probably the greatest potential of spectrographic analysis of used lubricating oils. By proper interpretation of the analyses, and with a background of previous analyses, the operating period between overhauls can be safely extended with the help of the spectrograph.

Ring wear . . . Table 2 is an example of an engine where the analyses began showing an abnormal increase in iron content. When it was overhauled in March 1956, micrometer readings indicated that approximately 0.003 to 0.005-in. of wear had taken place in the cylinders. All rings on several pistons were badly worn and had to be replaced. The top of one main bearing was also damaged and had to be replaced. This is indicated by the abrupt change in tin, lead, and copper on the January analysis. At this time silicon also increased.

This entire analysis, when reviewed in light of the subsequent overhaul, bears out the hypothesis of engine wear expounded by H. R. Sennstrom, of American Locomotive Co., which is roughly as follows: "It is surmised that dirt first damages the upper rings. As these rings continue to operate in a damaged condition, particles worn from their surfaces work downward through the assembly and cause damage to the lower rings and pistons. The wear particles then are carried to the bearings and cause scratching and deterioration of the bearing surfaces, as indicated by the increase of the bearing metal content in the lube oil."[2]

Crankshaft failure . . . The analyses in Table 2 are from an engine in which the crankshaft failed. Unfortunely this failure happened just after the second sample was taken and it is quite possible that this failure could have been prevented if sufficient previous spectrographic information about conditions in this engine had been available.

The November sample was taken just prior to the crankshaft failure and shows that tin, lead, and iron content increased greatly.

Bearing trouble . . . Tables 4 and 5 are examples which show plainly the fact that a single spectrographic analysis by itself is useless in attempting to predict failures, deterioration or excessive wear in engines. Table 4 is a series of analyses from an engine in which gradual wear was experienced in the rings and liners. When these reached a certain point of deterioration, bearing trouble began and got worse until the engine was overhauled.

The analyses show minimum values for everything for several months. A dust storm occurred in October and the air filters were cleaned on the basis of this analysis. At that time the iron content increased greatly. In December the iron had increased further and the lead and tin started to climb. In February and March the engine was overhauled. New liners, new rings, and seven new bearings were installed. At the time this happened our experience in the interpretation of these analyses was very limited so we only ventured a guess in early February that we might be having some bearing trouble in this engine. A review of the analyses after the overhaul greatly improved our ability to predict the condition of an engine by using spectrographic analysis.

Another case is a good example of how misleading a single analysis can be. A considerable amount of bearing trouble had been experienced at a station so spectrographic analysis of lube-oil samples was started at an early date. When the first analysis was received, we concluded that most of the bearings on this engine were gone. After a telephone conference in which the station manager assured us that the engine was running perfectly, we hesitantly agreed to wait for the next analysis report.

The company which was running the analyses for us telephoned as soon as it had analyzed the June 30 sample and informed us that it felt bearing failure was imminent in this engine. Immediately the engine was shut down and every bearing inspected and measured in every possible way. All of the bearings were good as new; absolutely nothing wrong.

In discussing the situation it was revealed that a plastic lead compound was used to seal the gaskets on the

TABLE 3—SPECTROGRAPHIC ANALYSES FROM ENGINE WHERE CHANKSHAFT FAILURE OCCURRED

	Metal content, p.p.m.						
	1955			1956			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Pentane insoluble	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Neut. number	1.1	0.7	0.7	1.0	1.3	1.8	1.4
Silicon	4	4	4	3	5	4	3
Iron	11	19	14	20	47	42	25
Chromium	1	1	1	1	1	1	1
Aluminum	2	2	2	2	2	2	2
Copper	1	1	1	2	1	1	1
Lead	16	26	13	6	14	10	10
Tin	3	6	4	4	3	2	2

TABLE 4—PROGRESSIVE WEAR AS INDICATED BY SPECTROGHAPHIC ANALYSIS

	Metal content, p.p.m.					
	1955				1956	
	Jan.	Aug.	Oct.	Dec.	Feb.	Apr.
Pentane insoluble	0.00	0.01	0.02	0.03	0.02	0.01
Silicon	1	2	4	1	1	2
Iron	1	3	11	27	21	10
Tin	1	1	1	2	3	1
Aluminum	1	1	1	1	2	1
Copper	1	1	1	1	1	1
Lead	1	1	1	2	7	2

TABLE 5—SPECTROGRAPHIC ANALYSES WHERE DETERGENT OIL IS USED

	Metal content, p.p.m.					
	1955		1956			
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Pentane insolubles	0.09	0.01	0.05	0.00	0.01	0.00
Neut. number	1.1	2.9	3.6	3.7	3.7	3.3
Silicon	16	8	4	9	9	8
Iron	89	70	70	75	75	75
Chromium	1	1	1	1	1	1
Aluminum	1	2	2	1	1	2
Copper	23	50	38	18	20	3
Lead	80	56	44	46	43	73
Tin	4	5	5	6	5	6

"We are not entirely satisfied with our success in predicting bearing trouble . . . Our success at predicting ring wear and air filter trouble has been much better and is approaching 70 per cent."

crankcase inspection plates. We confirmed that this was the source of lead in the oil by dissolving some of the compound in a sample of new oil, filtering the sample, and sending it off for analysis. The analysis of that sample showed 500 p.p.m. lead. Now we do not consider lead to be a reliable indicator of bearing trouble on engines where a lead compound is used to seal gaskets on inspection plates.

The examples just cited are especially selected cases which have been used to illustrate specific points of interpretation of spectrographic analyses of used lubricating oils. We have experienced almost as many failures as we have successes in interpreting and predicting wear. We are not entirely satisfied with our success in predicting bearing trouble. Thus far we have only predicted three cases out of eight correctly, and have had bearings fail in several engines where failure was not indicated. Our success at predicting ring wear and air filter trouble has been much better and is approaching 70 per cent.

Difference of Oil Types

All the engines represented in these examples are lubricated with a nondetergent, mineral oil mainly because most of our experience in interpretation has been with analyses of this type oil and we have been unable to draw any definite conclusions from analyses where a detergent-type oil is used. Table 5 will best illustrate this.

This engine was recently overhauled and only a negligible amount of wear found in any part of the engine, but based on our interpretive experience with nondetergent oils we would suspect that: (1) the bearings were gone as indicated by the high lead, tin, and copper values; and (2) the rings, liners, piston and crankshaft were about gone because of the high iron content. The greatest difficulty in interpreting analyses where detergent oils are used seems to arise from the fact that each oil company uses a different group of additives in differing amounts in compounding its detergent-type oils. More experience with detergent oils should help to overcome this barrier.

Spectrograph as a Tool

We have noticed that the different makes of engines tend to carry different normal levels of these metal contaminants in the lubricating oil, and we have also noticed that the same make engine when lubricated with different oils seem to have differing normal contaminant levels. So when these characteristics are combined with the many different combinations of operating difficulties, it becomes almost impossible to set out any set of rules for exact interpretation of spectrographic analyses. However, as we have gained experience and knowledge, we have been able to correctly interpret the results of this type analysis a greater percentage of the time.

We at Texas Gas look upon the spectrograph as a tool of great potential, but at the same time we realize that it is not yet in a position to take the place of our present maintenance procedures. We do not feel that spectrographic analysis of lubricating oils has been helpful to us in many ways.

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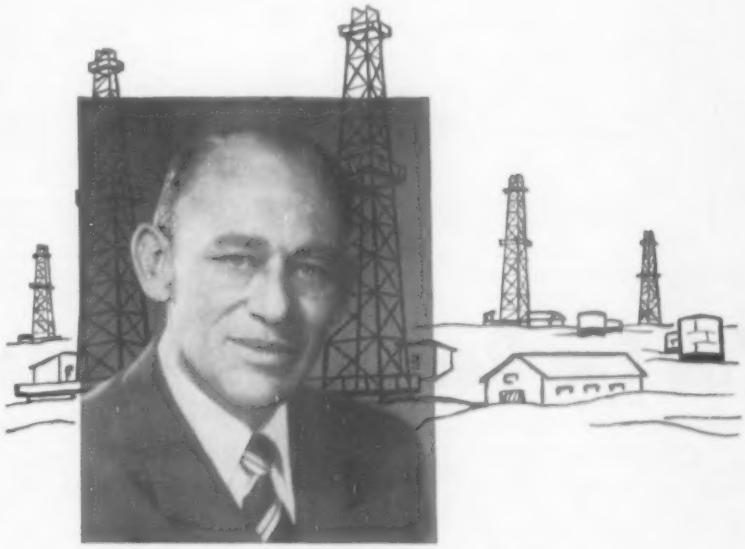

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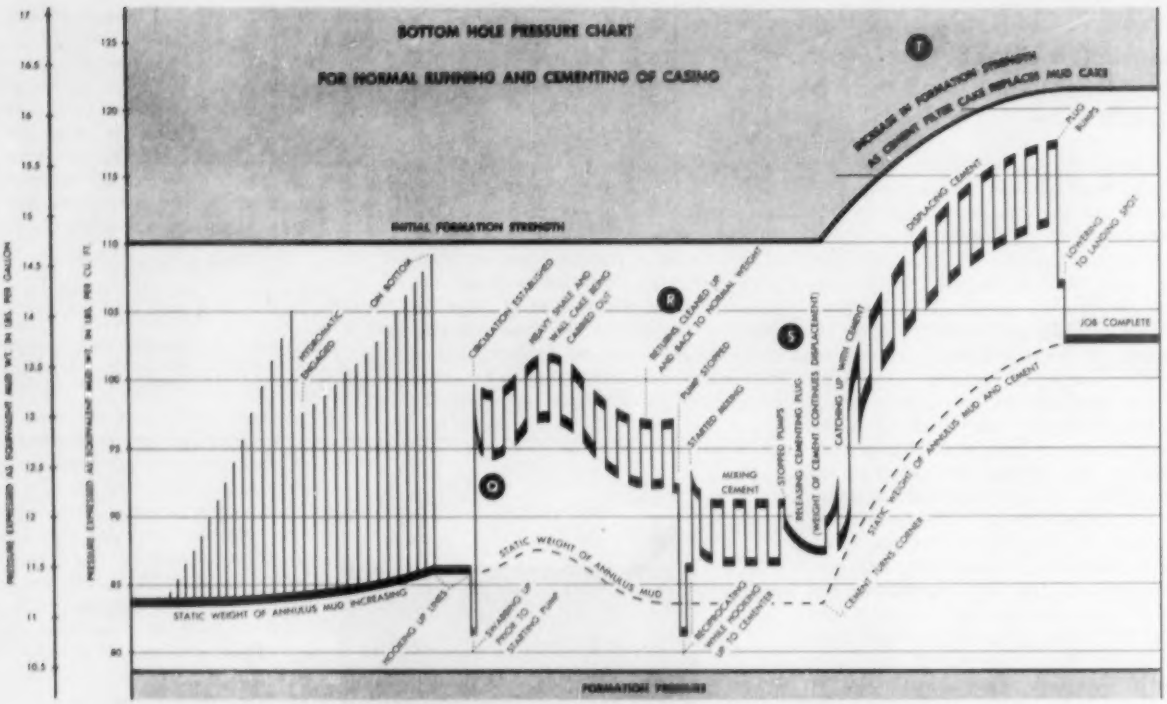

BOTTOM HOLE PRESSURE CHART
FOR NORMAL RUNNING AND CEMENTING OF CASING
INITIAL FORMATION STRENGTH
INCREASE IN FORMATION STRENGTH AS CEMENT FILTER CAKE REPLACES MUD CAKE
HYDROSTATIC INCREASED
ON BOTTOM
CIRCULATION ESTABLISHED
HEAVY SHALE AND WALL CAKE BEING CARRIED OUT
RETURNS CLEANED UP AND BACK TO NORMAL WEIGHT
PUMP STOPPED
STARTED MIXING CEMENT
STOPPED PUMPS RELEASING CEMENTING PLUG
WEIGHT OF CEMENT CONTINUES DISPLACEMENT
CATCHING UP WITH CEMENT
DISPLACING CEMENT
PLUG BUMPS
LOWERING TO LANDING JOINT
JOB COMPLETE
STATIC WEIGHT OF ANNULUS MUD INCREASING
HOOKING UP LINES
SWABBING UP PRIOR TO STARTING PUMP
STATIC WEIGHT OF ANNULUS MUD
RECIRCULATING WHILE HOOKING UP TO CEMENTER
STATIC WEIGHT OF ANNULUS MUD AND CEMENT
CEMENT TURNS CORNER
FORMATION PRESSURE
PRESSURE EXPRESSED AS EQUIVALENT MUD WT. IN LBS. PER GALLON
PRESSURE EXPRESSED AS EQUIVALENT MUD WT. IN LBS. PER CU. FT.

BOTTOM-HOLE-PRESSURE CHART for normal running and cementing of casing. Fig. 6.

You Can Reduce Lost-Circulation Problems

Circulation may be lost during casing operations as well as during drilling. Here is how it may happen and what the dangers are.

by E. H. Clark, Jr.

Part 2

MOST problems of lost circulation are encountered while drilling the open hole rather than during the casing of the well. This is true for a number of reasons: (1) During the drilling operation the hole is fresh, and deep seated, strong mud cakes have not yet been formed; (2) precautions of hole conditioning, pipe handling, and mud properties are not as rigidly followed during all phases of the drilling as they are during the casing job where supervision is very close; (3) overloading the hole with unremoved cuttings is not a major problem although a similar danger can exist, depending on the design and use of casing mechanical aids; (various types of scratchers and centralizers require different techniques and each manufacturer should be consulted for his recommendation in respect to the charactristics of his particular equipment), and (4) since new formations are not being penetrated on a casing job, there are no chemical inversions of the mud system due to formation contamination to complicate the picture.

On the other hand, however, there is always the potential danger of creating extremely high pressure surges when floating casing. This is particularly true (1) where large numbers of scratchers and centralizers are used; (2) where inadequate control is exercised over pipe handling characteristics; (3) where heavier muds are used, or (4), where annular clearances are small. Due to the fact that lost circulation during running of casing can lead to even more expensive results, such as stuck casing, inability to cement properly, or permanent damage to producing formations, it would be well to go through the illustration of a normal job of running and cementing a string of casing as well as a theoretical lost circulation job.

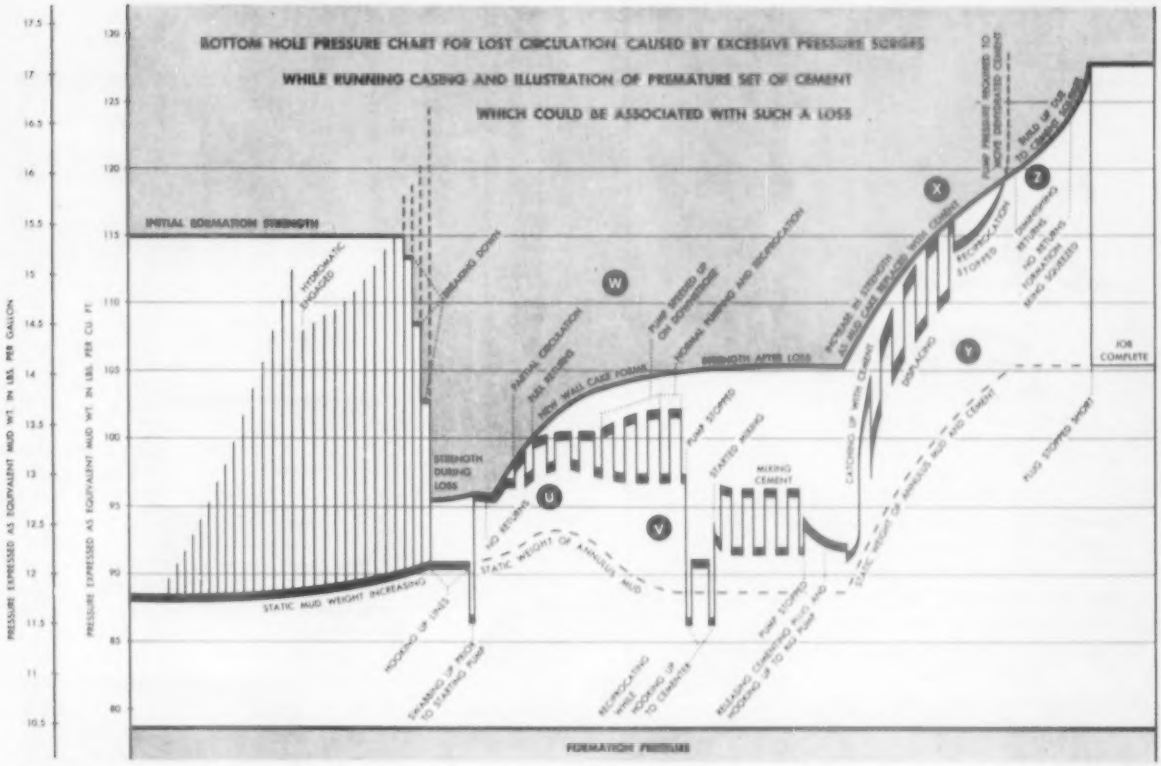
DRILLING

Normal Casing Job

Fig. 6 shows a bottom-hole pressure chart for normal running and cementing of casing. The pressure surges created are much higher than in the case of drill pipe, but the additional deep seated mud cakes formed over possible loss zones has raised the formation strength sufficiently to withstand these surges.

As of the pipe is being run a certain amount of wall cake or cuttings will be dislodged, the amount of which will depend a great deal on the design of the scratching and centering equipment. It is this rate of rise of the annulus mud weight which will determine how often circulation on the way in will be necessary, or whether it will be necessary at all.

After the cementing head and cementing lines are hooked up, the illustration shows an upward swabbing of the pipe prior to breaking circulation in order to lower net formation load dur-


BOTTOM HOLE PRESSURE CHART FOR LOST CIRCULATION CAUSED BY EXCESSIVE PRESSURE SURGES
WHILE RUNNING CASING AND ILLUSTRATION OF PREMATURE SET OF CEMENT
WHICH COULD BE ASSOCIATED WITH SUCH A LOSS
INITIAL FORMATION STRENGTH
HYDROSTATIC ENGAGED
STRENGTH DURING LOSS
STRENGTH AFTER LOSS
STATIC MUD WEIGHT INCREASING
STATIC WEIGHT OF ANNULUS MUD
NO RETURNS
PARTIAL CIRCULATION
FULL RETURNS
NEW WALL CAKE FORMS
NORMAL PUMPING AND RECIPROCATION
PUMP STOPPED
STARTED MIXING
MIXING CEMENT
CATCHING UP WITH CEMENT
DISPLACING
RECIPROCATION STOPPED
PUMP PRESSURE INCREASED TO MORE THAN CLOSING PRESSURE OF FLOAT VALVES
HOLD UP FOR 10 MINUTES
PLUG STOPPED SHORT
JOB COMPLETE
FORMATION PRESSURE
PRESSURE EXPRESSED AS EQUIVALENT MUD WT IN LBS. PER GALLON
PRESSURE EXPRESSED AS EQUIVALENT MUD WT. IN LBS. PER CU. FT.

B.H.P. CHART for lost circulation caused by excessive pressure surges while running casing. Premature set of cement, which could be associated with such a loss, is also shown. Fig. 7.

ing this operation (area Q). After circulation is broken, the pressure will slowly fall as gels are broken down but almost simultaneously will begin to rise as scratchers and centralizers dislodge heavy mud cake or loose formation. The stepped characteristic of the pressure line results from the continuing slow reciprocation of the casing. During this period, the static weight of the annulus mud will continue to rise, but eventually will reach a peak after which the well bore will begin to clean up and the mud will return to normal properties.

Clean hole . . . When such a point is reached (area R), the pumps are stopped while the lines are shifted from the rig pump to the cement truck. During this period, reciprocation is generally continued. The displacing pressures during the mixing period are somewhat lower because cement trucks generally have only one pump on the hole and furnish less volume than the larger rig equipment.

Both pumping and reciprocation are stopped in order to release the cementing plug and change back to the rig pumps when mixing is complete. Movement of the annular fluid will continue, however, due to the heavier weight of the internal cement column, thus maintaining a displacing pressure against the formation (area S).

In this example, the initial portion of the cement leaves the shoe shortly before this phase is completed and the static weight of the cement begins to add to the static weight of the mud. When pumping and reciprocation are resumed, it is first necessary to fill the void created in the pipe by the equalizing cement, and thus a period of catching up with the cement is necessary before displacement rates return to their normal values. The pressure pattern is pushed steadily upward as the additional weight of the cement continues to add load.

It should be noted (area T) that an increase in formation strength occurs simultaneously in the annulus due to the fact that cement filter cake is replacing the mud cake. It is this "strengthening and squeezing off" concept which makes it possible to raise columns of cement in areas which would not support a similar increase by surface pressure or a similar increase in mud weight. The reciprocation and displacement are continued until the plug bumps and the casing is landed to complete the operation.

Lost Circulation on a Job

When trouble does arise on a casing job it can manifest itself in a number of different forms, some of which can be disastrous financially. Fig. 7, however, shows the bottom-hole pressure for a job which could be completed even though lost circulation had occurred due to the creation of excessive pressure surges during running of pipe. Also shown on the chart is an illustration of how dehydration of the cement and loss of surface returns during the cementing job could be a byproduct of this action.

As the casing is run in the well, the floating surges, which are encountered during the latter portion of the trip in, go beyond the strength of the formation to the extent that the fluid once again finds it easier to fracture the walls or force its way into the formation than to return up the annulus. Higher flow rates from the larger displacement of the casing tend to break down the formation farther than the same number of surges with drill pipe which displaces less volume. Thus, when the casing has reached bottom and all necessary lines have been installed, circulation was initially impossible even though the swabbing action of the pipe was used to assist the pump.

When this condition was noted, the pumps were slowed down on the downstroke and speeded up on the upstroke. This method of keeping everything in motion prevented the pipe from sticking and eventually the heavy wall cake

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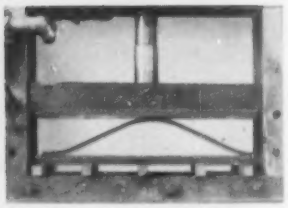
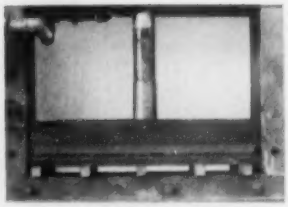
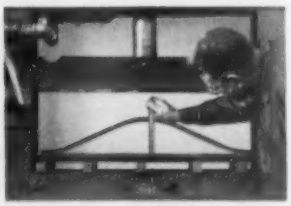


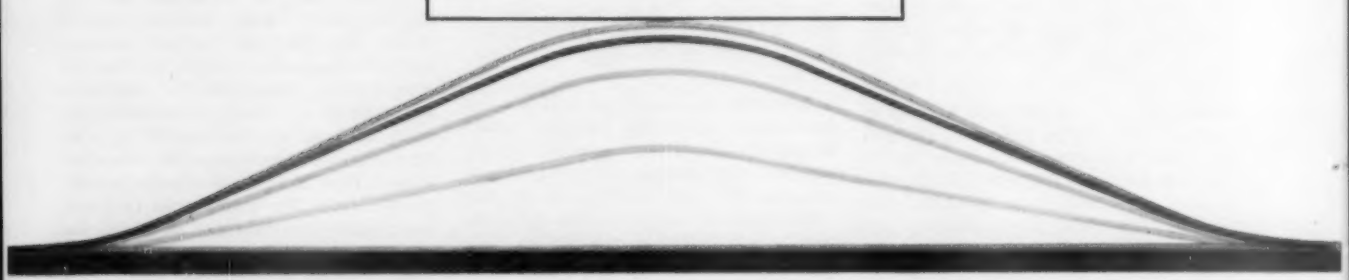
Spring in position in hydraulic press for flattening test.



The tightest hole could not flatten any spring more than this.



The specified bowed height (reach) must be present after the slight permanent set.



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and loose shale from the wall of the hole, in conjunction with lost-circulation material added at the surface, created a bridge on which the natural wall cake properties of the mud could build.

Thus, partial returns began and then full returns were received (area U). With returns established, the annulus mud weight began to fall, the pumps were slowly speeded up on the down-stroke and normal reciprocation was resumed. Eventually the well cleaned itself up without further incident (area V). During this period, the lost-circulation zone mudded off to a reasonable value as fluid invasion through the fissure ceased (area W).

Further danger . . . With the well cleaned up, the pumps were stopped so that lines could be shifted to the cement truck for mixing. The cement was mixed and, after mixing, pumps and reciprocation were stopped for releasing of the cementing plug and changing back to the rig pumps. As in the previous example, the cement turned the corner at this time and began to push the entire pressure pattern upward.

An increase in the strength of the formation is also noted simultaneously from replacement of the wall cake with cement but, due to the lowered strength in the loss zone, a danger to the cement job is still imminent (area X). When displacing is resumed with the rig pump and the fluid catches up with the cement, a normal rise in pressure is experienced. But, as these pressures begin to approach the strength of the bridged-off area, the cement in this section can be subject to considerable dehydration. This dehydration becomes evident both in decreased pumpability and in increased problems of reciprocation.

In area Y, reciprocation was stopped, but the increased pump pressure required to keep the partially set cement in motion led to even further dehydration and surface returns diminished. At this point (area Z), two things could happen: (1) the formation could be ruptured again to take the remainder of the cement freely, in which case the annular column could fall back and give a complete loss, or the dehydrated cement could hold the load above the loss point; or (2), the formation could accept and dehydrate the cement as in normal squeeze cementing. This latter concept is shown in the illustration where the squeeze pressure rose to the limit of the pumps, and displacement was stopped even though the cementing plug was short of the collar.

With the loss of surface returns, the static weight of the annular mud and cement does not change, since it is assumed that the additional cement went outward and did not alter the vertical hydraulic gradient. A job of this type, of course, has a good chance of being a successful casing job, as proved by the "hesitation" method of primary cementing which intentionally creates this same set of conditions. All cases of "loss and recovery" on casing jobs might not end up so satisfactorily, however, and the avoidance of the danger is the only safe procedure.

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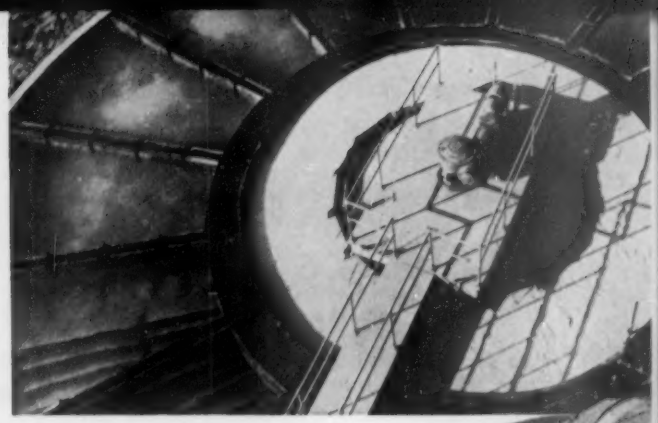

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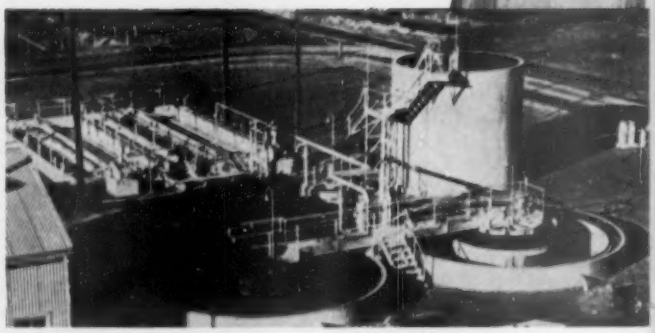

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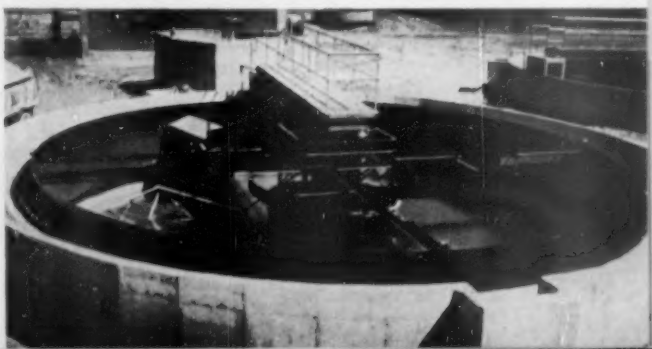

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Portable-Gasoline-Plant Symposium—5

Midget Plant Meets All Performance Demands

by F. H. Lacy, Jr., and G. B. Evans

ONE measure of any plant venture is its operating history. The Ropes plant, which has been in operation for about 3 years, has shown the following on-stream performance percentages: 1953, 99.25 per cent; 1954, 98.19 per cent; 1955, 98.76 per cent.

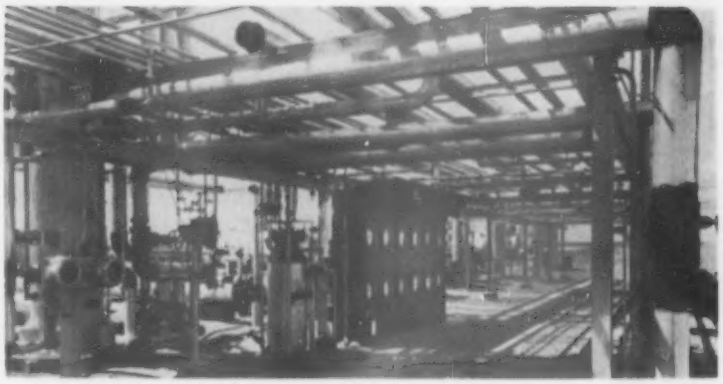
From inception, the entire plant force has consisted of one chief operator and two operators. In addition, one relief operator has been regularly utilized one shift per week and also has worked sickness and vacation schedules.

The field is shut in semiannually for 72 hours, for bottom-hole-pressure measurement. This time is not included in the above on-stream compilation. During these periods, all possible maintenance and repair is performed. Such periods are excluded from the on-stream time compilation above, since the plant cannot operate during these periods of no field-gas production.

Primary duties of the plant crew comprise the following: (1) operation of and routine maintenance on plant equipment; (2) product loading of all products into tank trucks, including preparation of run tickets; (3) all routine analyses required, including water and plant product streams; (4) field chart changing (7-day charts) and the calculation of gas volumes therefrom; (5) operation of and maintenance on field meters; and (6) preparation in pencil of all monthly plant and production reports. These reports are then checked and typed as necessary in the district office by clerical personnel. This district office clerical labor has averaged about 4 man hours per month.

While this list, taken together with the small size of the plant crew, has something of the ring of the story of a missing chore sometimes associated with a broom, in practice, quite the opposite has been found to be true. In 1955, Honolulu instituted the practice of giving an award to whichever of the plants it operates was judged best in over-all good housekeeping and operation. The personnel at Ropes won this award.

Authors are with Honolulu Oil Corp. Paper presented at the thirty-fifth annual convention, N.G.A.A., Fort Worth, April 11-13, 1956.



PROCESS INSTRUMENT PANEL is shown here. Base of deethanizer column is at far left.

It was hoped that the plant design would permit one operator to start the plant without assistance and put it on stream in a minimum of time, without undue effort. It has been found in practice that after a 72-hour shutdown, one operator can bring the plant from no-flow to specification products, in 3 hours. Less than 1½ hours of operator time is required during this period.

The alarm and shutdown system incorporated in the plant was designed to be a reliable and extra-safe system, which the operating personnel would desire in continuous operation. In the 3 years of its history, there have been three failures of the alarm and shutdown system itself: (1) an electrical short in a lead to the shutdown and alarm panel; (2) hydrate formation in a Bourdon tube in a pressure alarm. (This has been prevented since by the addition of glycol once per year); and (3) a faulty switching device. (This device has since been redesigned by the manufacturer).

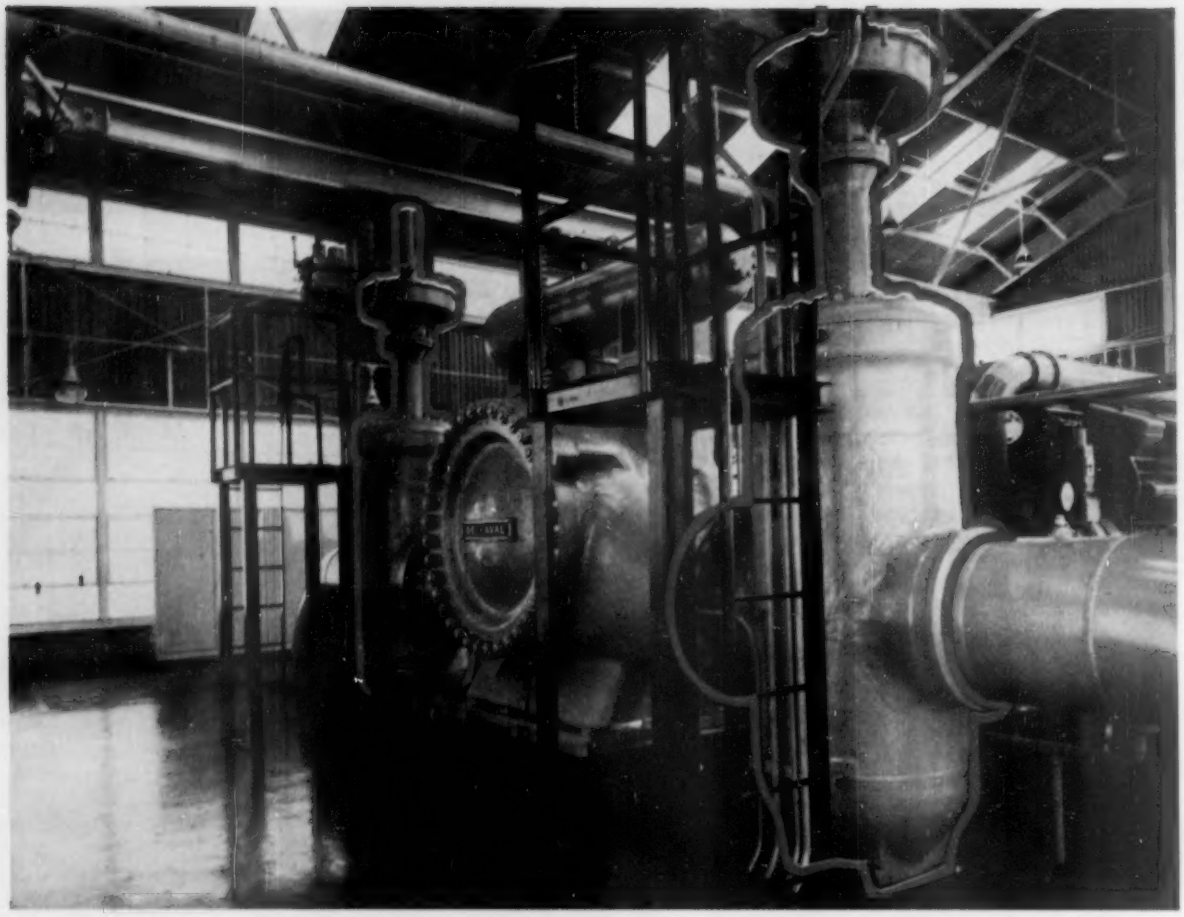
The operators are not only satisfied with the alarm and shutdown system, but have found it so reliable and helpful that any indications of malfunction are given top priority for checking and repair.

Plant recovery has averaged 10 gal. of total-liquid product per M.c.f. of inlet gas. Typical component-recovery percentages, together with temperature and pressure data, are shown in Table 2.

Hudson Engineering Corp. designed and constructed Ropes plant for the Signal Oil & Gas Co. and Honolulu Oil Corp., the joint owners, who have found that the plant performance has completely met all their expectations and requirements.

TABLE 2—RAW PRODUCT-DEETHANIZER OPERATION

Raw product surge tank:	
Pressure, psig.	500
Temperature, °F.	35
Per cent of rich gas condensed:	
C_3	82.0
iC_4	92.9
nC_4	93.5
iC_5+	98.2
Deethanizer:	
Pressure, psig.	465
Feed temperature, °F.	36
Overhead to reflux condenser, temperature, °F.	112
Dry gas temperature, °F.	38
Bottom temperature, °F.	259
Per cent of feed retained:	
C_3	85.9
iC_4	97.7
nC_4	98.3
iC_5+	99.5
Over-all plant recovery, per cent:	
C_3	70.5
iC_4	90.7
nC_4	91.9
iC_5+	97.7



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Enrichment of Vapors Carried Out in Column

INSTEAD of a series of stills, the enrichment of vapors in lower-boiling-range fractions is carried out in a fractionating column which is made up of a series of chambers or plates one above the other. A portion of a simple tower is shown in Fig. 2.

The plates or trays are provided with a riser covered by a cap, so designed that the vapors passing upward through the riser are forced to bubble through liquid on the tray. Such trays are, therefore, referred to as bubble trays. Liquid reflux flows downward from one tray to the next lower one through a down pipe.

Same function . . . One tray in the fractionating tower performs the same function as a still in the previous example. Vapors leaving tray A pass upward through the riser in tray B into the cap which forces the vapors to bubble through liquid on that tray. The vapors give up their heat to the liquid, causing the heaviest boiling-range fraction to condense and flow back to tray A. The heat supplied to the liquid on tray B causes the lighter boiling-range fractions to vaporize and pass upward to tray C. By such successive steps almost any desired separation of products is accomplished.

Consider the fractionating column as being divided into two sections; one portion being that section above the feed tray, and the other being the section below the feed tray. The upper section is referred to as the fractionation or rectification section, and the lower portion is known as the stripping section.

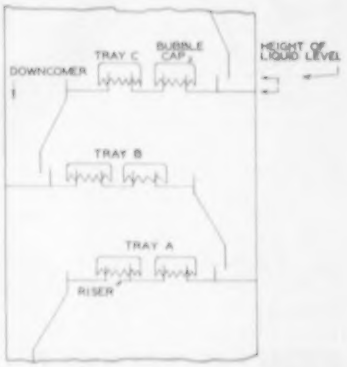
The bottom section removes from the liquid feed all of the lighter fractions not desired in the bottoms product. The stripping of the remaining feed in this section of the column is accomplished by a stream of vapors originating at the base of the column. This vapor is either steam or hydrocarbon vapors produced by reboiling action.

The vapor passes up through the bubble cap trays and strips the fraction desired in the overhead from the liquid on the trays flowing down the column. Fractions desired in the bottoms also are partially stripped or vaporized from the descending liquid so that fractions which belong in the bottoms are found in the vapors above the top tray of this section.

The vapors from the stripping section mix with the partially vaporized feed and start upward through the column, passing through the risers in the successive trays. Vapors passing from the top of the column are cooled and part of the condensed portion is returned to the top tray as reflux to cool the rising vapors. The top tray then is the coolest point within the column. On each tray there condenses a liquid fraction that is condensible at the temperature of that tray. The vapors from the tray below bubble up through the cooler liquid, which condenses the heavier fractions.

The latent heat given up on condensation causes the lighter fractions in the liquid to boil. The vapor thus formed, along with the vapor which did not condense in bubbling through the liquid on the tray, passes upward through the risers on the next tray to bubble through its liquid.

Condensed liquid . . . As vapor condenses on a tray, the condensed liquid spills over into the down pipe and so on to the tray below. This liquid, or most of it, is vaporized again there and joins the other rising vapors, to bubble up through, and be condensed again on its former tray. Thus, each fraction of oil is vaporized and then condensed into liquid and again vaporized and so on over and over until it is removed from the system.



PORTION of Bubble-Cap Tower. Fig. 2.

Each of the vaporization and condensation cycles tend to segregate on each tray a more uniform fraction, more and more free from lighter or heavier fractions. Where a separation of more than two fractions are desired from a column, the desired fractions are allowed to flow out through drawoffs as side streams.

Light vapors . . . The lightest vapors do not condense in the column, but pass up through all the trays and out the overhead vapor line to the condensers. A portion of the overhead is used as reflux which cools the rising vapors and is again vaporized and passed overhead. The balance of the overhead is withdrawn from the system. Thus, the overhead fraction (a pure hydrocarbon or a definite-boiling-range fraction), like the heavier fractions in the stripping section, is subjected to repeated cycles of vaporization and condensation.

If the liquid on the top tray collects a heavier fraction than the overhead, it eventually will flow down the column through the pipes to the tray where it belongs.

This material is taken from "Fundamentals of Refining," operating manual of Magnolia Petroleum Co., refining division, Beaumont, Tex.

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PIONEER IN CATALYSIS

Painting Costs Provide Maintenance Guide

by J. O. Jackson* and Joseph Bigos†

IN considering the economical facts of painting as a corrosion allowance, if we figure the cost of the capital investment at 5 per cent per year, then the situation is as follows:

For a 20-Year Period*

	Increasing steel thickness costs		
If steel costs (cents per lb.)	Steel (cents per sq. ft.)	Interest (cents per sq. ft.)	Total (dollars per sq. ft.)
50	80	80	1.60
40	64	64	1.28
30	48	48	0.96
25	40	40	0.80
20	32	32	0.64
15	24	24	0.48
10	16	16	0.32

*Painting costs, 32-44 cents per sq. ft.; interest 24-33 cents per sq. ft.; total, 56-77 cents per sq. ft.

Painting-investment cost is spread over the years and carries a lesser burden of interest. With steel almost as low as 15 cents per pound, painting is still competitive with adding steel for a corrosion allowance.

Regardless of influencing variations in the preceding figures, a basic fallacy exists in the use of over-all corrosion rates in predicting life expectancies. Experience proves that failure is almost always a result of greatly accelerated corrosion of a localized nature. Tanks fail along welds or rivets at bottoms or corners; structural steel fails at joints or crevices; and roofing fails at laps. Because of this localized corrosion, caused by galvanic cells, crevice corrosion, continual wetness of joints, etc., over-all corrosion rates need to be multiplied by factors of 10 to 100 to predict real life.

Good painting practice . . . Normally, painting for the sake of protection alone cannot be justified in such areas as steel exposed to dry or arid atmospheres, building interiors, or building frames to be encased in concrete or enclosed in masonry. It is reasonable to expect this of present building construction.

The steel exposed in the interior of a building with an atmosphere below 70 per cent relative humidity does not rust. Because the slight corrosion that may occur cannot be considered structurally detrimental, painting is often done for the sake of good appearance rather than for protection.

As the corrosivity of the environment increases, the life expectancy of steel decreases. At the same time, the cost of painting increases because better methods and more resistant materials are required. For example, an average life of $\frac{1}{8}$-in.-thick tank roofs in sour-crude service is 8 years. McConomy and Hur show by an economic comparison that interior paints or organic coatings for tank roofs must last for 2 to 3 years to break even in cost with replacement steel $\frac{1}{8}$-in. thick which has a life expectancy of 6 years.

When good design eliminates many sources of localized corrosion, doubling or tripling of the life is possible. Then, actual life will begin to approach the life expectancy calculated by over-all corrosion rates.

As the humidity increases, the need for protection increases. At very high humidity—particularly in the presence of corrosion-accelerating agents such as sulfur dioxide or salt—the need for protection may demand good, and usually expensive, painting. Each project requires individual evaluation, and the painting program should take cognizance of both the service conditions and the desired results.

The most important factors to cover in specifications to assure good service from paint systems are:

1. Proper design to minimize corrosion and paint failure and to facilitate repainting.

2. Preparation of the surface to a degree consistent with the intended service exposure and requirements of the priming paint to be used.

3. Correct application of paint in a manner that insures maximum paint life yet is commensurate with practical limitations.

4. Selection and use of paints that are formulated properly and can perform the required service.

The protection of steel structures exposed to the atmosphere or immersed in water is made difficult by the mill scale found on structural steel. Mill scale consists of oxides of iron which form on steel as a result of the rolling operations. The steel is heated to a high temperature and rolled while hot. Direct oxidation of the steel occurs during this process. Most of the scale which forms during the actual rolling operation is knocked off in subsequent passes through the rolls and by operations designed to remove this rolling scale.

After having been rolled to the desired shape and thickness, the steel is allowed to cool. It is during this cooling that the mill scale ordinarily is encountered on structural steel forms. The steel is then shipped to the fabricator.

During these processes of cooling, handling, storage, and shipping, the mill scale becomes cracked and loosened to varying degrees. Some of the steel surface begins to rust.

Because mill scale consists of oxides of iron, there is a reduced tendency for oxidation of the surface to occur. Mill scale may be protective to the steel surface under many conditions, but, unfortunately, cannot always prevent corrosion.

When the mill scale is intact, it constitutes a good base for painting and will give long, satisfactory paint life upon exposure to mild atmospheres; the paint life may equal or surpass that on blast-cleaned or pickled steel. This is only true for intact mill scale—a surface condition which, as a result of fabricating procedures, is seldom encountered in actual practice.

*Pittsburgh-Des Moines Steel Co., Pittsburgh. †Senior fellow, Mellon Institute of Industrial Research. Paper presented at A.P.I. Refining Division meeting, Montreal, 1956.

References

1. McConomy, H. F., and Hur, J. J., "Economics of Metals and Coatings to Combat Corrosion Refinery Tanks Roofs," A.P.I. Proc. 32M (3)72, 1952.

by W. L. Nelson
Technical Editor

COST-imating

14. Cost of Steam-Generation Equipment

THE cost[1,4,5] of small and large boiler installations is indicated in Fig. 1. Small package-type boilers can be installed for an extra 50 (largest) to 60 (smallest) per cent of the boiler equipment shown in Fig. 1. An installation may consist of boiler, furnace, superheater, economizer or air heater, boiler mountings, fans, firing equipment, a stack, field erection, and as indicated for refinery boilers in the center of Fig. 1. More complete field erected or large installations may also include a boiler meter, temperature recorders, feed-water regulator, automatic combustion control, deaerator feed heater, and some type of water treater. If coal is fired, coal-handling and ash-handling systems are also needed, as well as dust collectors. Such complete jobs are indicated near the right of Fig. 1 and these costs lack only a stack, breeching, and a building to house the boiler. The costs of controls, water treaters, deaerators and pumps are indicated in Reference 3.

References

1. Marshall and Stevens, Steam Power Index, Chem. Eng., March 1956, p. 194.

2. Nelson, W. L., The Nelson Refinery Construction Cost Index, The Oil and Gas Journal, July 27, 1952, p. 105. (The Nelson Index also appears in the first issue each month as well as a comprehensive list of indexes in the quarterly issues of January, April, July and October.)

3. Durham, E., Chem. Eng. Costs Quarterly, April 1954.

4. Small Gas and Oil-Fired Steam Boilers, Chem. Eng. Costs Quarterly, Jan. 1952, p. 16.

5. Nelson, W. L., Pipe Stills, The Oil and Gas Journal, April 7, 1949, p. 109.

STEAM POWER PLANT INDEXES,[1,2] 1946 = 100

	Steam power equipment[1]	Steam power M. & L.	Plate steel	Boiler tubes	Nelson construction[2]
1946	100	100	100	100	100
1947	122	118	117.5	115	117
1948	132	130	140	131.3	132.5
1949	132	134	134.8	140.7	139.7
1950	137	140	136	149.5	146.2
1951	146.5	149	156.1	163.3	157.2
1952	147	153	153.4	168.8	163.6
1953	149	159	150.3	188.3	173.5
1954	151	164	147.3	199.4	179.8
1955	155.5	169	154	220	184.2

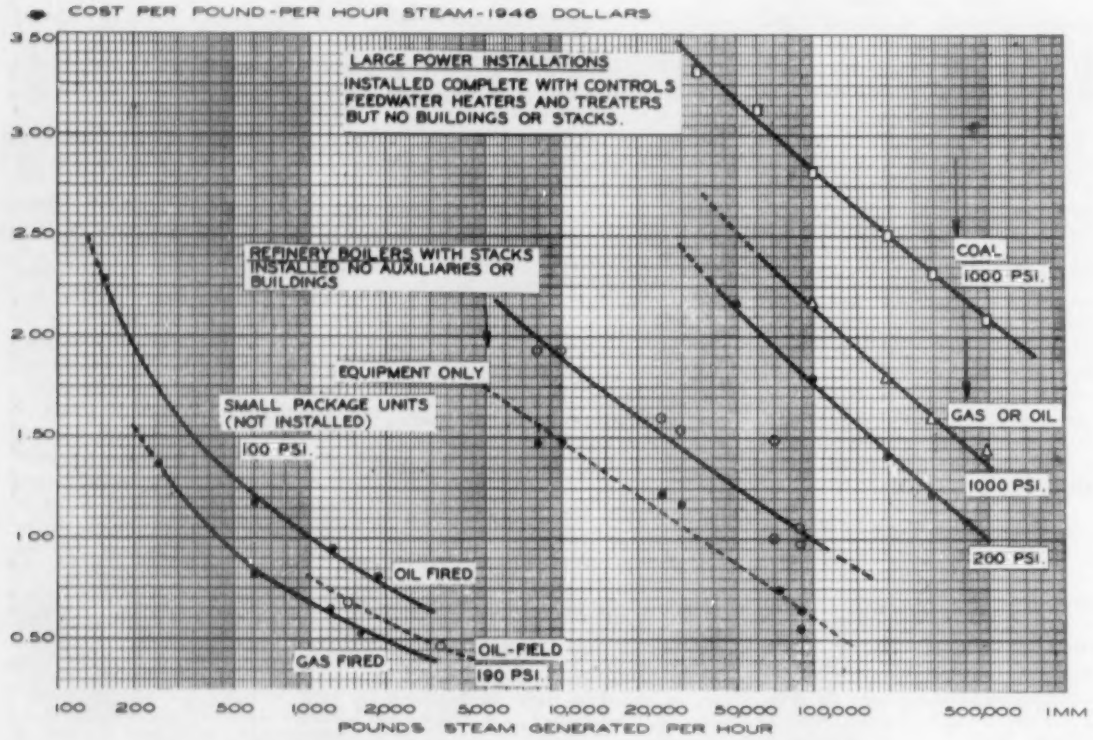

Fig. 1—Approximate cost of steam-generating equipment during 1946, dollars.

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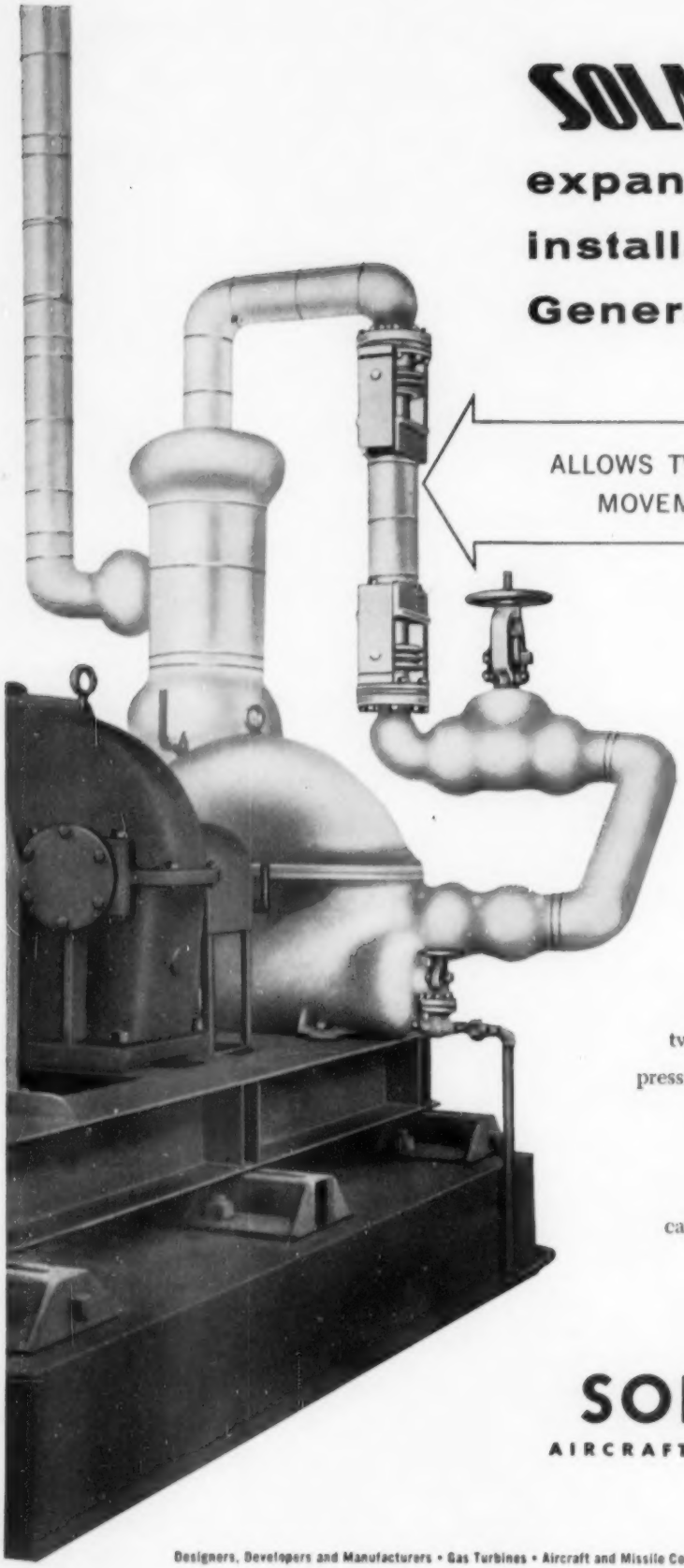

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OPEN-AIR DESIGN features Southern Pacific's products pipeline station at El Paso. Shown are general utility building at left, pump building, and office at far right.

SUCTION MANIFOLD to which shippers deliver to SoPac. Four different products are handled. Double valves in manifold prevent contamination.

OUTGOING SCRAPER TRAP with motorized valves on both trap and bypass. J. R. Davis, chief operator-deliveryman, stands beside scraper trap.

Southern Pacific's pump station moves . . .

14,000 bbl. daily by pushbutton control

by Larry Resen
District Editor

A MODERNISTIC pumping station marks the beginning of Southern Pacific Pipelines, Inc., products pipeline running westward from El Paso to Tucson and Phoenix.

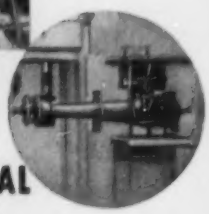
The completely electrified station is set up for pushbutton control. Two 300 hp. pumps move 14,000 bbl. per day of products into the 8-in. main line under 1,400 psi. discharge pressure. All valves are motor-operated and can be operated at the valve or from a console in the control room.

Under the setup, four products—diesel fuel, kerosine and two grades of motor fuel—are being moved out of the station, which was placed on stream early this year. Four shippers; The Texas Co., Gulf Oil Corp., Standard Oil Co. of California, and Shell Oil Co., pump products directly into the intake manifold at the station. A fifth shipper—McNutt Refining Co., now a part of El Paso Natural Gas Products Co.—will move products in via truck from its crosstown refinery. Three 20,000 bbl. floating-roof tanks are provided to store these products prior to shipping.

Station layout and design conforms to local climatic conditions. For instance, hay tanks, strainers, meters, pumps, and motors are located within a semienclosed structure. This roofed structure has aluminum louvers extending downward about halfway from the roof on all four sides. The equipment is protected from the strong direct rays of the sun by these louvers. Prevailing breezes in the area assist in cooling as they pass through the louvered overhead section.

A switching station with its controls and instrumentation is located within an air-conditioned brick building adjacent to the semienclosed equipment structure. This building also serves to house auxiliary compressors, a locker

VERTICAL



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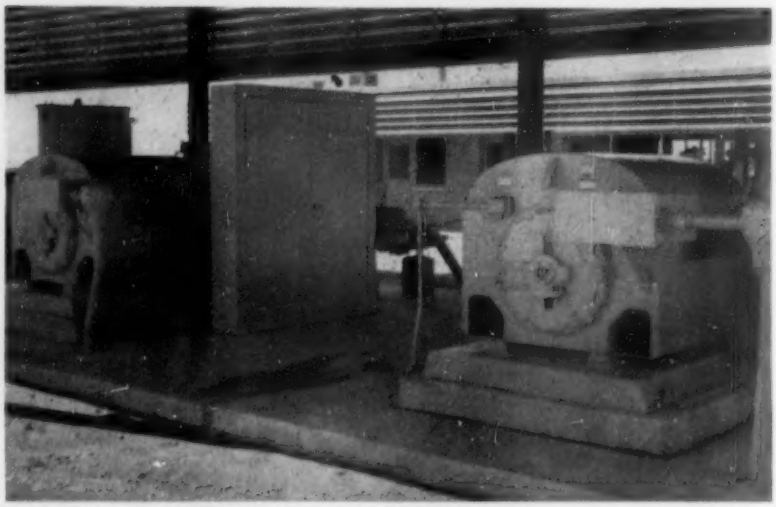
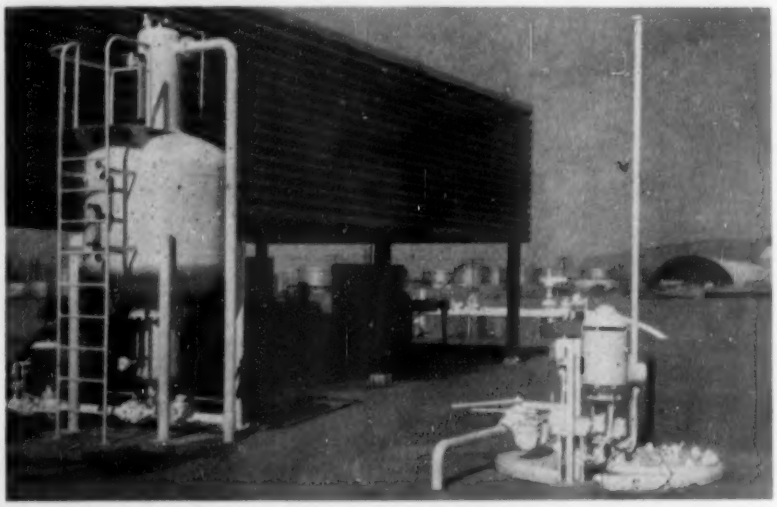
PIPELINE PATROL



MAIN PUMP UNITS are housed in semiopen building with louvered siding. These 300 hp. motors drive 5-stage pumps in series in a discharge pressure of 1,400 psi.



METER PROVER TANK and station sump pump. Meters are proved periodically or with change in gravity of 3° A.P.I.

room, and laboratory. Offices and a maintenance area are located in two other brick buildings. Electrical switchgear is stored in exposed cabinets in this low-humidity area.

Products flow . . . In tracing the flow through the station, products first pass through a double-valved manifold. Motor operated valves are remotely controlled from the console. Adjacent to the manifold is a local auxiliary control board which can be used when desired. As noted, products are received directly into the manifold without being stored except for one case, when they are first received into the storage tanks. When pumping from these tanks, booster pumps and tank manifolds are controlled also from the console.

The products pass through two hay tanks connected in parallel and then through three wire-mesh strainers and on through three meter runs. The strainers and meters are connected in parallel, and the product stream can be split to pass through as many meter runs as desired. With each meter having a capacity of 575 bbl. per hour, the full station flow of 14,000 bbl. per day can be spread over a total meter capacity of over 17,000 bbl. per day. This insures accurate metering without overloading.

Each of the meter runs is equipped

Pipeline Patrol

STATION IS CONTROLLED from this graphic panel as demonstrated here by J. A. Baldridge, operator-deliveryman.

with dual meters and a transfer manifold so meters can be switched conveniently at each product change. A Warner-Lewis prover tank is tied into the meters and used for calibration purposes. The meters are calibrated at least every 7 days or whenever there is a 3° change in product gravity. A chemical injection pump is used to add inhibitor to the products streams which are tied together downstream of the meter runs.

Series operation . . . The products are picked up by two 5-stage centrifugal pumps operating in series. Average suction pressure is 85 psi. and the discharge is 1,400 psi. as previously noted. The pumps are driven by 300 hp. motors. An air-operated control valve is located on the downstream side of the pumps and this is used to control both mainline pressure and throughput. A scraper trap on the outgoing manifold is used to launch brush-type scrapers periodically. Three scraper traps are included in the 424-mile line between El Paso and Phoenix.

Construction of the system and station was handled by Engineering Management, Inc. R. E. McKee, El Paso, was prime contractor on this station.

Station supervisory personnel include R. R. McDaniel, district superintendent; and Jack R. Davis, chief operator-deliveryman.

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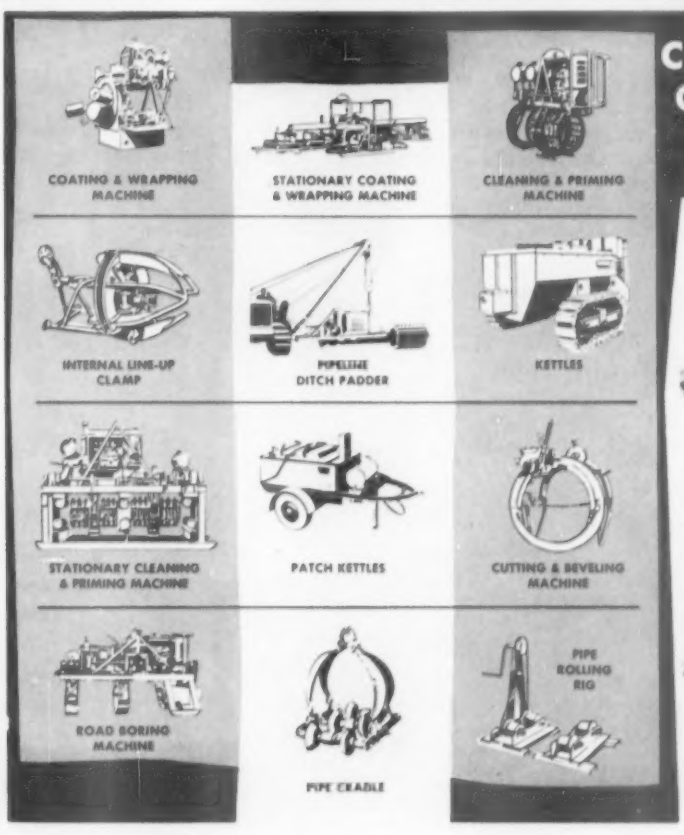

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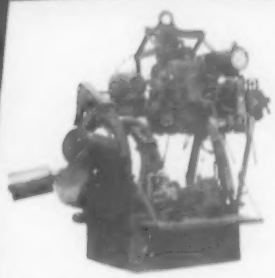

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Drilling Contractors

Loffland Bros. has contract for a 13,500-ft. wildcat offshore from Cameron Parish in the Gulf of Mexico, South Louisiana. The West Cameron Block 2 wildcat will be drilled for Pure Oil Co. at 1-A State Lease 2760. Location is in the Creole area.

Offshore Co. has contract for a 15,000-ft. wildcat in Plaquemines Parish, South Louisiana. The well will be drilled for Tidewater Oil Co. at 1 A. A. Gilmore in 16-21s-28e.

Rowan Drilling Co. has contract for a 12,500-ft. Venice area test in Plaquemines Parish, South Louisiana, for Tidewater. The 90 Buras Levee District is in 27-21s-30e.

Glasscock-Wilson, Inc., Shreveport, La., will drill Seaboard Oil Co.'s third deep test in the Maurice area, of northern Vermilion Parish, coastal Louisiana. The new test, 1 Baudoin, is in the next section west of Seabord's discovery well, completed last March as a gas-condensate producer from Miocene sand at 11,380-94 ft. This operator's other test, 1½ miles southwest of the discovery well, was dry at 13,126 ft.

Independent Drilling Co., Aberdeen, S. D., is contractor on a rank wildcat test General Crude Oil Co., of Houston, is undertaking in Tripp County, South Central Dakota, in the upper Central Nebraska basin. Location, at 1 Assman Ranch, in 22-98n-78w, is southwest of Winner townsite. The operation marks General Crude's debut to the general northern Rocky Mountain region.

Falcon Seaboard Drilling Co., Tulsa, and Houston, is drilling on another deep wildcat test for H. B. Zachry, of San Antonio, in the Cameron area, coastal Cameron Parish, Louisiana. Location is 2 miles south of production, and just inshore from the Gulf of Mexico, near the mouth of Calcassieu River. It is a 13,500-ft. operation.

Meredith & Co., Houston, has a new contract job in Acadia Parish, southern Louisiana. It is an 11,600-ft. wildcat test for Kilroy Co. of Texas at 1 Heinen, in 14-8s-1e, about 13¼ miles northeast of North Crowley field, about 9 miles north of Crowley.

Mesa Drilling Co., Denver, has a new contract operation in the Ute Trail area, 6 miles west of Chapita Wells, Uintah County, northwestern Utah. It is for Havenstrite Oil Co. at 83X-9H Unit, in 9-10s-22e.

Longhorn Drilling Corp., Three Rivers, Tex., is working at two new wildcat locations in southwestern Texas. One is a 10,500-ft. Edwards lime test for C. V. Lyman, of Midland, Tex.,

Two new offshore drilling barges built for Penrod Drilling Co., of Shreveport, are named for two of the company's veteran drillers: W. H. (Bill) Dordan, third from left; and Tom Sorrell, right. With them on the rig floor of one of the barges at twin christening ceremonies at Levingston shipyards, Orange, Tex., are their wives, who christened the barges, and N. H. Hall (left), and W. F. Youngblood (second from left), assistant drilling superintendents.

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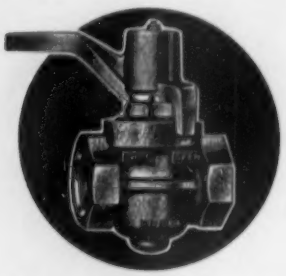

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at 1 Scott Petty, 3½ miles south of Artesia Wells, in LaSalle County. The other is a 10,000-ft. test for Warren Petroleum Corp. at 1 Whitley-Johnson Unit, 6 miles northwest of George West, in Live Oak County.

Black Hills Drilling Co., New Castle, Wyo., has contracted for a 9,300-ft. Ordovician test to be drilled for Garfield & Pasternak, of Denver, at a wildcat location 22 miles south of Mizpah, in Custer County, eastern Montana. Location is on government land in 20-2n-52e.

Bush Drilling Co., Eunice, La., has contracted for a 7,950-ft. test Robert Mosbacher and others will drill 2½ miles north of Northwest Juanita field, in Beauregard Parish, southwestern Louisiana. Location is listed as 1 Rice, with spot in 29-4s-1w.

Larco Drilling Co., Jackson, Miss., is on a new deep contract-job for Jett Drilling Co., of Shreveport, in the Lake Bruin area, Tensas Parish, eastern Louisiana. It is a Lower Tuscaloosa test with depth objective about 9,200 ft. Location is a mile from production. Designation of the test is 1 Harris. Spot location is 33-12n-12e.

Branyon Drilling Co., Cushing, Okla., has contracted for a Mississippian test to be drilled for Cosden Petroleum Corp. at a rank wildcat location 9 miles northeast of Lamar in northwestern Prowers County, southeastern Colorado. Location is on a state lease in 16-22s-45w.

Nowery Drilling Co., Shreveport, has a new wildcat operation in Shelby County, eastern Texas. It is a contract job for Texas Eastern Transmission Co. and Winwell Exploration Co. Location, at 1 Adams, in the J. M. Wiggins Survey, is 4 miles east of Tenaha. Contract is for 6,800 ft.

Clay Chiles Drilling Co., Alice, Tex., has a rig under contract to LaGloria Oil & Gas Co. for a 6,000-ft. wildcat test 13½ miles south of Hebbronville, in Jim Hogg County, South Texas. Location, on a Mestina Oil & Gas lease, is in Block 3, Fowler and Rankin Subdivision, Palitos Blancos Grant.

Butler-Johnson, Inc., Shreveport, has scheduled a 6,800-ft. Travis Peak test to be drilled 1½ miles northwest of Mansfield, in DeSoto Parish, North Louisiana. It is a contract job for L. E. Smith and L. G. Cameron and associates, also of Shreveport. Location, at 1 Brooks, in 6-12-13w, is 4½ miles from production in Logansport field.

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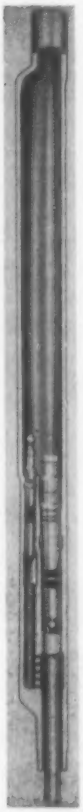
Mandrel Incorporates Two Tubing Landing Nipples



A new mandrel for permanent-type well completions incorporates a standard side-pocket mandrel and two tubing landing nipples into one unit. The PC mandrel is designed with tubing landing and sealing nipples adjacent and parallel to the side-pocket receiver section. Thus, gas-lift valves, dummy valves, chemical-injector valves, and circulating valves may be seated in the side pocket, and extension hangers and tubing blanking plugs may be landed in the contingent tubing nipple.

Extension pipe is suspended from the hanger for washing sand or performing squeeze cementing operations. A dummy blanking valve seated in the side pocket above entrance ports from the casing annulus directs the circulation of fluid from the casing annulus through the side pocket and around the extension pipe. With the dummy valve and extension hanger removed and a blanking plug or check valve seated in the lower tubing nipple and sealed below the circulating ports, fluid can be circulated from the casing annulus to the tubing without allowing pressure on the producing formation.

The mandrel provides an excellent means for killing a high-pressure well without pumping into the formation. A blanking plug can be seated in the tubing receiver nipple and sealed above and below the circulating ports and the tubing filled with fluid. A dummy blanking valve is removed from the side pocket and the well is circulated and killed without mudding the formation.

The mandrel may be used for gas lifting or chemical injection with valves installed in the side pocket and with the parallel tubing nipple empty. Perforating guns, pressure bombs, and other wire-line tools will pass through the mandrel which has a minimum tubing diameter of 1⅛-in. **For more information write or call: Camco, Inc., Box 14484, 7010 Ardmore, Houston 21, Tex.**

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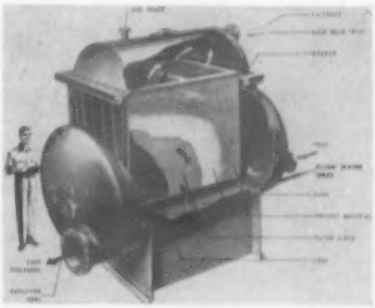

Hi-Rate Filter Made For Secondary Recovery

The new Hi-Rate pressure water filter is recommended for oil-field secondary-recovery operations as well as for other water-filtration applications which require a high-capacity unit.

The Hi-Rate pressure filter is an upflow, precoated, leaf-type pressure unit. It comprises ten rectangular filter leaves housed in a closed tank surmounted by a dome in which filtrate is collected. The leaves are suspended in the tank from a slotted plate which also serves as a partition between feed compartment and dome. Slots in the plate correspond with the openings at the top of each leaf, thus permitting an unrestricted upward flow of filtrate from the interior of the leaves into the dome.

The Hi-Rate filter is equipped with a single point, remote-control system by means of which each step of the operational cycle, precoating, filtration, and backwashing, is closely regulated. The filter is available as a complete, ready-to-operate unit. It can be incorporated into the flowsheet of an operating plant merely by connecting the four inlet and discharge ports and electrical service. **For more information write or call: Dorr-Oliver, Inc., Barry Place, Stamford, Conn.**

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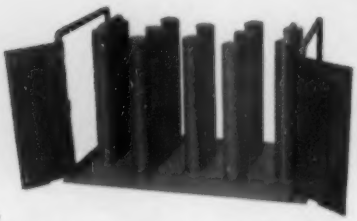
OF NEW EQUIPMENT



Magnetic Cleaner Removes Metal From Drilling Mud

A magnetic mud cleaner provides a means whereby cuttings and small metal objects having magnetic attraction can be removed from the drilling mud, thus contributing materially to a longer useful life for the pumps and for some of the tools in the drilling string. During and for a period of time following milling operations and window-cutting operations, large quantities of metal cuttings are introduced into the drilling fluid. Because a lot of these cuttings will always pass through the shaker, the magnetic mud cleaner has proven to be an effective device for removing this damaging material.

The magnetic mud cleaner is installed by placing it in the mud ditch below the shaker. When submerged in the mud ditch, all of the drilling mud must pass within the field of its magnetic elements. Metal cuttings and small objects are attracted and adhere to the clean-off tubes. They are cleaned off by picking up a clean-off unit. This takes the cuttings way from the magnetic elements and the unwanted metal then falls away. **For more information write or call: S. R. Bowen Co., P. O. Box 427, 11008 South Norwalk Boulevard, Santa Fe Springs, Calif.**

●

Stop Collar Eliminates Welding Slugs on Casing

A new tool eliminates the necessity of welding slugs on casing to hold scratchers and centralizers. This new tool, the J-2S stop collar, was developed as a welding substitute since welding damages casing in several ways.

The J-2S stop collar incorporates high-quality steel friction springs which fit between the tapered seat on the inside of the collar and the surface of the casing. When the stop collars are installed, the springs are wedged between the collar seat and the casing, holding the collar stationary and limiting the travel of the scratchers and centralizers.

The stop collars come in two models. One will hold to 5 tons for average-depth wells, the other to 20 tons for deep wells. Both models are easily installed. **For more information write or call: Weatherford Oil Tool Co., 5920 Navigation Boulevard, Houston, Tex.**

Pipeliner Excavator Is Designed for Contractor

A new model excavator-crane, called the Pipeliner, features a carbody of a new wide, deep design equipped with removable bottom-cover plates. Crawler rollers and tumblers are sealed against dirt. Crawler shoes and pins are of heat-treated alloy steel. The excavator-crane is available with either a gasoline or diesel engine.

The Pipeliner is available with 24 or 30-in. shoes and 12-ft.-6-in.-long crawlers. Travel speed with single-

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A FOUR ENGINE AIRCRAFT
TO A SINGLE ENGINE AIRCRAFT

RIGELE

Plus These Added Features:

Interchangeability of Components — All generators used on RIGELECTRIC units are interchangeable. All of the heavy duty traction type electric motors are the same size. **Multiple Engine Dependability** — On the Model S241000 RIGELECTRIC power package, four 250 H.P. engines with a combined capacity of 1000 H.P. are used instead of using, as in some electrical arrangements, only one power unit to drive one or two generators. The Stewart & Stevenson multiple engine arrangement is far more reliable and dependable inasmuch as one power unit can be out of service for some reason and still the efficiency of the RIGELECTRIC unit is hardly impaired.

America's Newest and most Flexible
engine Electric drilling Rig power
offers the Dependability of Four
engines instead of only one

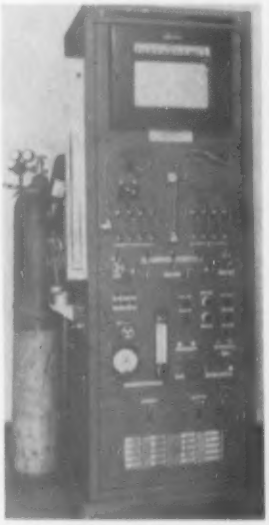
speed transmission is 0.8 m.p.h. The speed is 0.8 m.p.h. and 1.6 m.p.h. with optional two-speed transmission.

For more information write or call: Insley Manufacturing Corp., P. O. Box 167, Indianapolis, Ind.

●

Instrument Analyses Gases, Liquefied Gases, Liquids

The Model 1111A Chromagraph analytical instrument shown here is a mobile unitized instrument embodying the best features of the many laboratory gas liquid partition chromatography apparatus evolved in several years research in this field at Shell Development Co. It is suitable for analysis of gases, liquefied gases and liquids by adsorption as well as by gas-liquid partition techniques or combinations thereof.



Separation of isomers is readily handled at temperatures down to zero °C. with self-contained refrigerating unit, and materials boiling at temperatures approaching 400° C. can be analyzed at operating temperatures of 250° C. and higher. It has been successfully applied to the analysis of full-range cracked gas, other saturated or aromatic compounds, oxygenated and halogenated compounds, various alcohols and aldehydes, light aliphatic acids and esters. **For more information write or call: Hallikainen Instruments, 1341 Seventh Street, Berkeley 10, Calif.**

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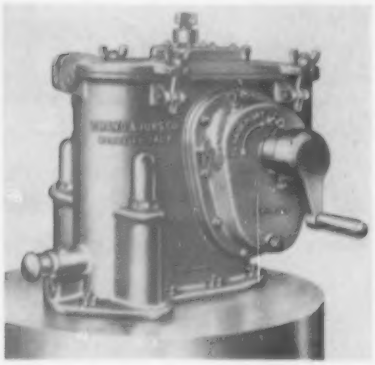

Automatic Marine Gage Eliminates Inaccuracies

A new automatic tank gage determines the distance from the high cu-

DESIGNED FOR THE OIL FIELD BY OIL FIELD POWER SPECIALISTS

AVAILABLE THROUGH RIG MANUFACTURERS AND SUPPLY STORES

RIG

STEWART & STEVENSON

Simple Controls — The RIGELECTRIC control system does not require the use of contactors in the operational function. The control is so simple that it requires only a fraction of the normal amount of space. Trouble shooting is accomplished easily without the need of highly technical personnel.

Longer Engine Life with Less Maintenance Cost — Maintenance cost with Stewart & Stevenson RIGELECTRIC sets is much lower than the comparable life with the same engines on a mechanical driven rig due to the constant speed operation of the engines.

Reduced Fuel Consumption — The fuel consumption is lower with RIGELECTRIC because the engines are operating at their most efficient speeds constantly.

DIRECT PARTS AND SERVICE RESPONSIBILITY — Stewart & Stevenson is completely and fully responsible for the entire design, function and servicing of both electrical and engine components.

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.....OF NEW EQUIPMENT

pacity line to the liquid surface in the compartments of tankers. The marine gage employs a constant force Neg'ator spring which eliminates any need for a counterweight and the accompanying tube or housing for it. This spring exerts a constant force no matter how far below the gage head the float may be riding on the liquid and how much of the tape may be hanging free above the float.

This automatic marine gage provides improved visibility of the reading tape, an adjustable tape-reading pointer, and highly corrosion-resistant Teflon bearings throughout. The tape-storage drum has a trough built around it so that it may be immersed in an antifreeze solution to prevent fouling this part by freezing condensate. **For more information write or call: Shand & Jurs Co., Berkeley, Calif.**

●

Two 600 Hp. Diesels Power Frac Unit

A new fracturing unit is ready for field service. The Twin T-10 is mounted on a standard Lo-Boy trailer and is powered by two Cummins VT-12 600-hp. diesel engines. This is twice the horsepower of earlier types and its horsepower provides 70 per cent more hydraulic power. The increased hydraulic horsepower assures drillers of speedier fracturing service and eliminates the need for extra equipment.

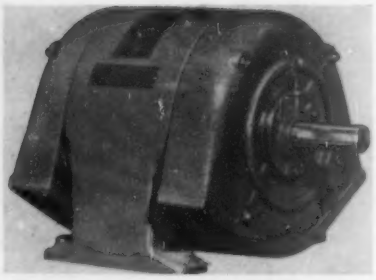
The Twin T-10 pumps have large plungers reducing fluid-friction loss and making possible a volume of 28 bbl. per minute. Hydraulic horsepower has been increased to 880 hp. per unit. **For more information write or call: Halliburton Oil Well Cementing Co., Duncan, Okla.**

●

All-Weather A. C. Motor Designed for Pumping Unit

A down-draft, dripproof, three-phase, a.c. electric motor is designed for oil-field use such as on oil-well pumping units.

All-weather construction of the motor renders it resistant to varying temperatures and climatic conditions. Vents are shielded against entry of small animals, reptiles, and weeds. Bearing housing has a large lubrication reservoir. Offered is a gasketed, weatherproof cable entrance or a conduit box. It is available in wide horsepower range. **For more information write or call: Brook Motor Corp., 3553 West Peterson Road, Chicago 45, Ill.**



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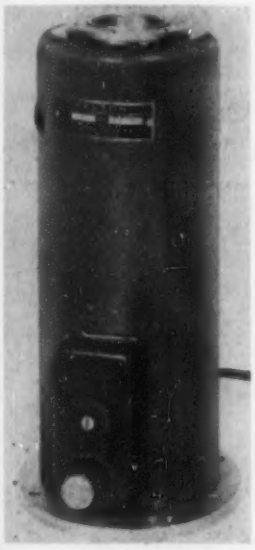

Cylinder Heats Crude For Gravity Readings

An improved type of heating hydrometer cylinder called the Melton unit is built to provide a practical way of heating samples of waxy crudes so that hydrometers will float in them, thus assuring correct gravity readings of such samples. The cylinder is explosionproof and is of all-aluminum construction. The unit has a strip-type heating element which may be easily replaced in the field. It has a thermostatically controlled heating range of approximately 50° to 240° F. and is furnished with removable pyrex inner cylinder. Inside dimensions conform to A.P.I. specifications. The cylinder can be furnished for 6 and 12 volts d.c. or 115 volts a.c. **For more information write or call: L-K Pump Valve Co., P. O. Box 901, Houston, Tex.**

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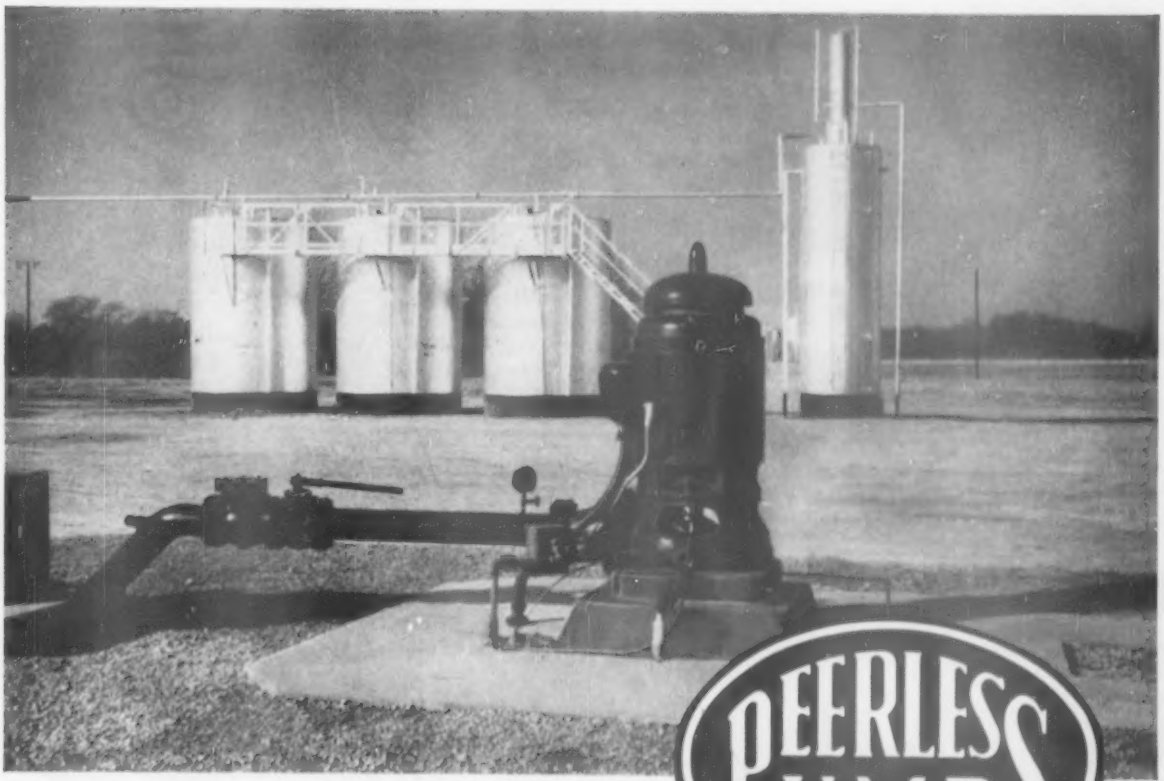
PUMPS SET AT 1000 FEET LIFT WATER IN SECONDARY RECOVERY PROJECT



PEERLESS PUMPS

HERE'S WHY A PEERLESS VERTICAL TURBINE PUMP IS THE BEST, MOST PROFITABLE PUMP TO APPLY TO LIFT SOURCE WATER

1 PROVED AND TESTED ON THE DEEPEST SETTINGS—Because of variables of water conditions, lifts, motor speeds involved, Peerless engineers design each pump for the individual conditions of the well and geographical location in which it is to be installed. Peerless' application of chemistry, metallurgy and hydraulics assures dependable and highly efficient pump operation, over the years.

2 ENGINEERED THROUGHOUT TO SPECIFICATIONS—Peerless possesses the broadest experience in successful designing, engineering, manufacturing and supervision of installing the deepest turbine pumps. Each pump component from the rugged triplex motor bearing to the suction manifold is Peerless tested and proved by years of successful manufacture that has established Peerless as America's sales leader of this type of pump.

3 LOWEST IN MAINTENANCE YET EASIEST TO SERVICE—Experience based on operating records proves that a Peerless vertical turbine pump is the least expensive over the years to buy, install and maintain. An experienced Peerless field engineer near you can demonstrate this is the lowest cost pump for lifting water from deep wells, all factors considered.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Factories: Los Angeles, Calif. and Indianapolis, Indiana.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis; Phoenix; Fresno; Los Angeles; San Francisco; Plainview and Lubbock, Texas; Albuquerque, New Mexico.
Distributors in Principal Cities. Consult your Telephone Directory

Quick Facts ON THE PICTURED INSTALLATION

LOCATION: Fayette County, Illinois. OPERATOR: Major oil producing company. NO. OF WELLS: 5. SETTING OF PUMPS IN WELLS: 1000 feet. HP OF MOTORS: 150 hp at 1800 rpm. CAPACITY: 10,000 bbls/day. TYPE OF PUMPS: 3 Peerless Water Lubricated Pumps, 2 Peerless Oil Lubricated Pumps; each are of vertical rotative shaft turbine type. PUMP CYCLING: Intermittent and continuous. PUMP MATERIAL: All iron.

MAIL COUPON FOR INFORMATION

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26, Los Angeles 31, California

Please send full information on the application of Peerless vertical turbine pumps to water lifting in secondary recovery projects.

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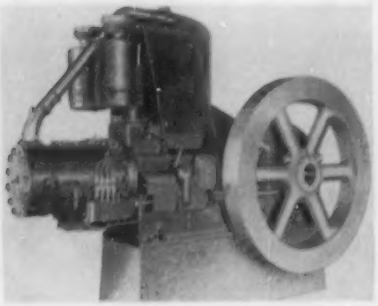
OIL AND GAS JOURNAL *Showcase* OF NEW EQUIPMENT



New 115-Hp. Gas Engine Offers 200 to 360 R.P.M.

A new 115-hp. DP-115 gas engine designed to handle the heaviest oil-field assignments delivers 15 per cent more power, at greater fuel savings, than the previous models. Bore is 13¼ in. and stroke 16 in.

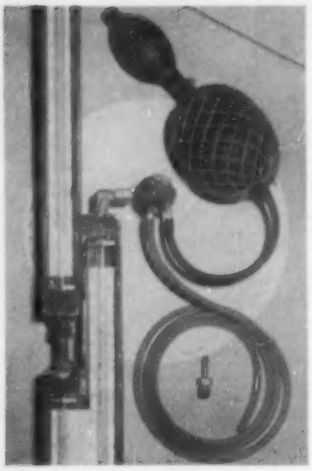
This engine maintains an essentially flat torque curve, delivering required horsepower to operated pumps or other equipment over a wide speed range. Recommended speed range is 200 to 360 r.p.m.

Directional porting of cylinder intake ports is a design feature. This sweeps the maximum amount of exhaust gases from the cylinder by accurately targeting incoming gases, thus achieving exceptional scavenging efficiency. Other noteworthy features are thermosyphon cooling and dual air filters for the combustion chamber. Gas-injection equipment is optional. **For more information write or call: Ajax Iron Works, Corry, Pa.**

Instrument Testing Aided By Use of New Manifold

The Phenix testing manifold has been designed to meet the need for a compact, portable device for connecting the compressed air supply with the manometer and the instrument being tested. This new manifold is expected to speed the work of technicians in testing the accuracy of differential-pressure instruments by the comparison method.

With the Phenix tester the need for multiple manually operable valves and cumbersom manifolding is eliminated. So compact is this new equipment that



it may be held and manipulated by hand. The testing manifold is a disk-type arrangement that utilizes the bulb and tube set for its air supply when not more than 9-lb. pressure is required.

The unit features instant action when applying or venting air and fine control for testing. **For more information write or call: Robert H. Welker, Phenix Testing Co., P. O. Box 106, Clifton Springs, N. Y.**

AIR-OPERATED VALVES

The fact that the Klinger valve has no seat but is sealed by resilient packing rings which are compressed round a sliding piston, means that power is only required to move the piston from one position to another and no power is required to maintain the valve in the closed or open position. Valves are manufactured with bronze, forged or case steel bodies, screwed or flanged, with stainless steel pistons and spindles as standard, in sizes from ½" to 6" bore. Tapped air connections are provided at each end of the air cylinder. The valves have been designed for operation with an air supply at a pressure of about 70 p.s.i., although in certain circumstances it is possible for the valves to operate at pressures down to 50 p.s.i.

Klingermatic air-operated valves are ideally suited for remote control of filling lines, emergency valves, where rapid operation is desired and such similar applications.

Write to your Klinger agent for descriptive leaflet and literature.

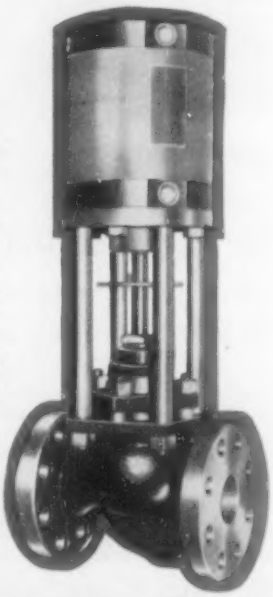


Illustration shows Klingermatic Air-operated Valves being used as remote-controlled filling and emergency valves on a gas bottling plant.

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

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Homco supply people are on the job 24 hours a day. Whatever you need, whenever you need it—the Homco man is waiting to help you with prompt efficient service. With years of experience in the oil fields, he can usually fill your needs from store stocks. However, he can also get the unusual and hard to find equipment, fast.

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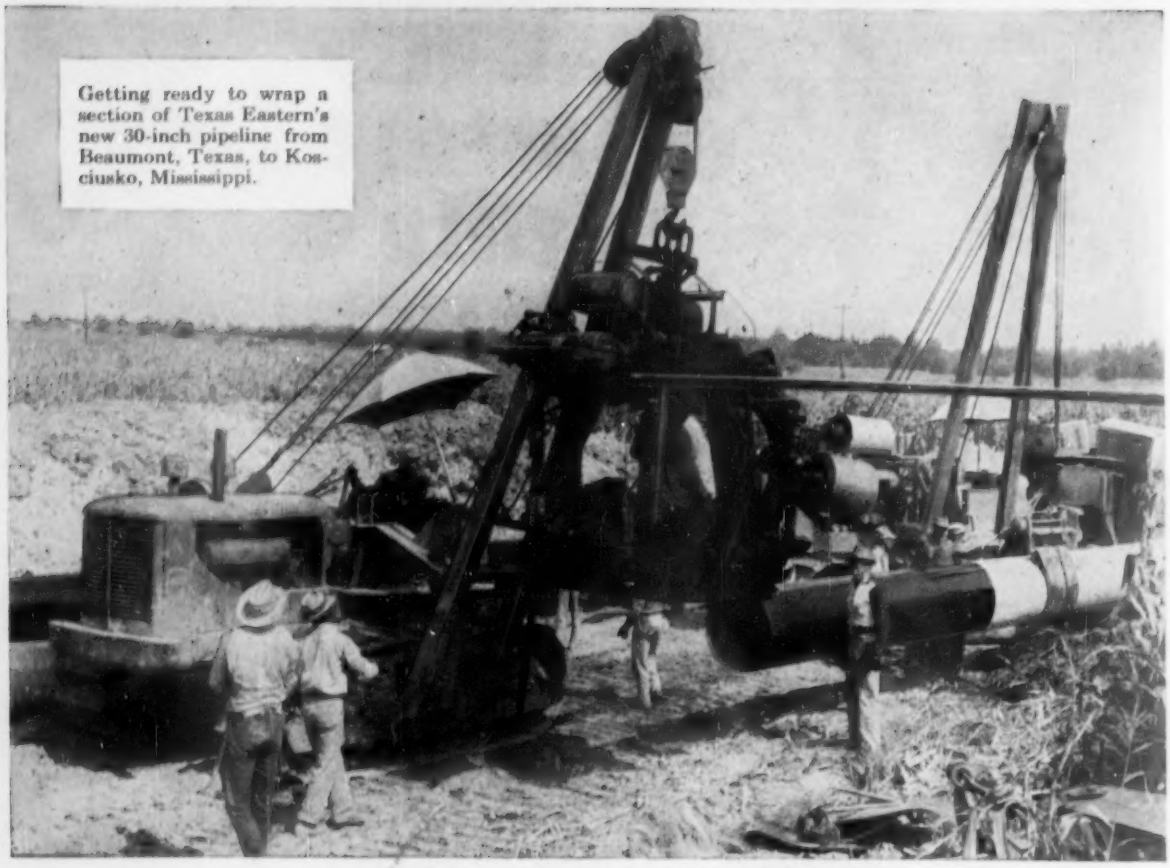
PIPELINE news from L·O·F GLASS FIBERS COMPANY



Getting ready to wrap a section of Texas Eastern's new 30-inch pipeline from Beaumont, Texas, to Kosciusko, Mississippi.

Texas Eastern used Blue Flag to help protect its new 30-inch pipeline

Companies with large pipeline investments know they can rely on L·O·F Glass Fibers' Blue Flag Reinforcing Pipe Wrap. A Blue-Flag-reinforced coating prolongs pipeline life years longer than unreinforced coatings . . . yet costs less than .5% of the original investment!

Here are other reasons why Blue Flag increases application efficiency, helps protect pipelines from corrosion . . .

- High tensile strength virtually eliminates breakage in the field!
- Uniform porosity allows hot enamel to bleed, and trapped gas to escape quickly—keeps "holidays" to a minimum!
- Retards cold flow of the enamel!
- Increases enamel strength!
- Helps protect coating from backfill damage!
- Made of special inert glass which resists action of soil chemicals.

Blue Flag Reinforcing Pipe Wrap is available from strategically located distributor warehouses. For full details, write *L·O·F Glass Fibers Company, Dept. 78-76, 1810 Madison Avenue, Toledo 1, Ohio.*

L·O·F GLASS FIBERS
BLUE FLAG
PIPE WRAP

L·O·F GLASS FIBERS COMPANY
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Makers of glass fibers by the exclusive "Electronic-Extrusion" process

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It's Easier to Open or Close a Golden-Anderson Valve Than to Drive a Car With Power Steering is the title of the new Bulletin G-4. With the aid of easy-to-follow drawings, the reasons for the claim are explained. Additional features of cushioned automatic valves are also covered, plus a brief resume of 11 of the firm's complete line of specialty valves in sizes from 2 to 36 in. **For more information write or call: Golden-Anderson Valve Specialty Co., 1265 Ridge Avenue, Pittsburgh 33, Pa.**

●

Pipe Covering and Block Insulation. Two folders contain physical data, specifications, and recommended thicknesses. Hylo pipe covering and block insulation is described in the four-page Form A-400 as serving a complete range of temperatures from a high of 1,600° F. to a low of 100° F. It has high thermal efficiency and structural strength and can be used in single-layer applications. Eighty-five-per cent magnesia pipe covering and block insulation is covered in the six-page Form A-401. This material is designed for use on pipes or vessels carrying medium or high-pressure steam at temperatures up to 600° F. **For more information write or call: The Eagle-Picher Co., American Building, Cincinnati 1, Ohio.**

●

Aluminum Pipe for Oil-Industry Service. The long service life of aluminum pipe is described in a new booklet. Aluminum pipe's other advantages are economy, installation, easy portability, and corrosion resistance. Aluminum tubular products serve many purposes as supply piping for rigs and for other operations where lines must be readily movable. **For more information write or call: Aluminum Co. of America, 780 Alcoa Building, Pittsburgh 19, Pa.**

●

Standard Centrifugal Process Pumps. A 12-page, 2-color booklet gives operating information on the Series 10, 20, and 30 pumps for industrial, refinery, field process, petrochemical, and general service. The simplicity of design and interchangeability of parts is explained in Bulletin 184. A table gives pump sizes for Series C (for temperatures up to 350° F.) and for Series R pumps (for high-temperature service). Another page gives head-capacity range charts. Annotated sectional views and parts lists are presented for each series. **For more information write or call: Dean Brothers Pumps, Inc., 323 West Tenth Street, Indianapolis 7, Ind.**

●

Unit Mariner, a 12-page booklet, describes a revolving crane built specially for offshore drilling platforms. The three-color Bulletin MO-200 contains pictures of the crane including the three-cylinder General Motors diesel engine and torque converter installed on a drilling platform. The cab and controls are shown with annotations. Specifications and working ranges are stated. Engineering drawings are of the cab, turntable, and boom. **For more information write or call: Unit Crane & Shovel Corp., Milwaukee 14, Wis.**

●

V-Belt Trouble-Saving Tips. Three self-mailers are offered to help users of V-belt drives diagnose many of the common causes of trouble in their drives. Cartoon-type drawings illustrate each trouble-saving tip. The mailers are sized to tack up on the wall near the drive or to attach to the machinery itself for quick reference. Mailer V-1400-M39P tells how to keep V-belt drives delivering maximum r.p.m. Mailer V-1400-M38P points out how to select proper drives, install belts, and check alignment. Mailer V-1400-M40P illustrates symptoms of V-belt failure and gives cures for all kinds of V-belt troubles. **For more information write or call: Worthington Corp., Harrison, N. J.**

●

Wire Rope Is a Machine, a 96-page manual, contains information on the selection, installation, and best operating practices for wire rope. Included in this revised edition is new material on the applications of JalKlamps and JalFlex slings. **For more information write or call: Wire Rope Division, Jones & Laughlin Steel Corp., Muncy, Pa.**

●

Geon 8700-A and 8750. A new eight-page technical bulletin on rigid unplasticized polyvinyl chloride compounds Geon 8700-A and 8750 deals specifically with the use of these compounds in the manufacture of rigid vinyl pipe and fittings. Two tables are

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included. One summarizes typical physical properties determined on the requisite test specimens representing the two compounds, and the other tabulates a series of characteristic chemical-immersion results. Illustrated with actual application photos, the three-color booklet is intended to acquaint the pipe consumer with the inherent properties of Geon rigid polyvinyl-chloride compounds and the applications which products made from them typically serve. **For more information write or call: B. F. Goodrich Chemical Co., 446 Rose Building, Cleveland 15, Ohio**

●

Pipeline and Utility Ditchers. A new 16-page catalog covering the recently introduced 305, 307, and 308 pipeline and utility ditchers illustrates and describes a number of new engineering developments, including the hydraulic conveyor drive, live hydraulic wheel-hoist controls, and traction and digging transmissions. **For more information write or call: Gar Wood Industries, Inc., Wayne, Mich.**

●

Infrared Spectroscopy. Scientists, engineers, and technicians interested in learning more about infrared spectroscopy can now obtain a package of reprints on the subject. Included in the package are the following basic introductory articles on infrared spectroscopy, spectra-structure correlations in the infrared region, analysis of hydrocarbons via infrared spectrophotometric instruments, and ultraviolet and infrared spectrophotometric analysis of an insect-repellent mixture. Also included is Bulletin 472 on the new IR-4 infrared spectrophotometer and a complete index of all infrared reprints now available. **For more information write or call: Scientific Instruments Division, Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.**

●

Series V Self-Operating Temperature Regulator. This new bulletin gives information on the standard Stacon Series V, self-operating temperature regulator recommended for steam, water, gases, and all fluids not corrosive to brass. It operates on a liquid-filled thermostatic system, either direct or reverse acting. The direct-acting model is designed for applications on hot-water heaters, tanks, and fuel-oil heaters. The reverse-acting model serves such operations as jacket cooling (for compressors, diesel, and gas engines) brine circulating, and process cooling. **For more information write or call: A. W. Cash Co., P. O. Box 551, Decatur, Ill.**

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For smooth, free plunger operation under all kinds of pumping conditions it is

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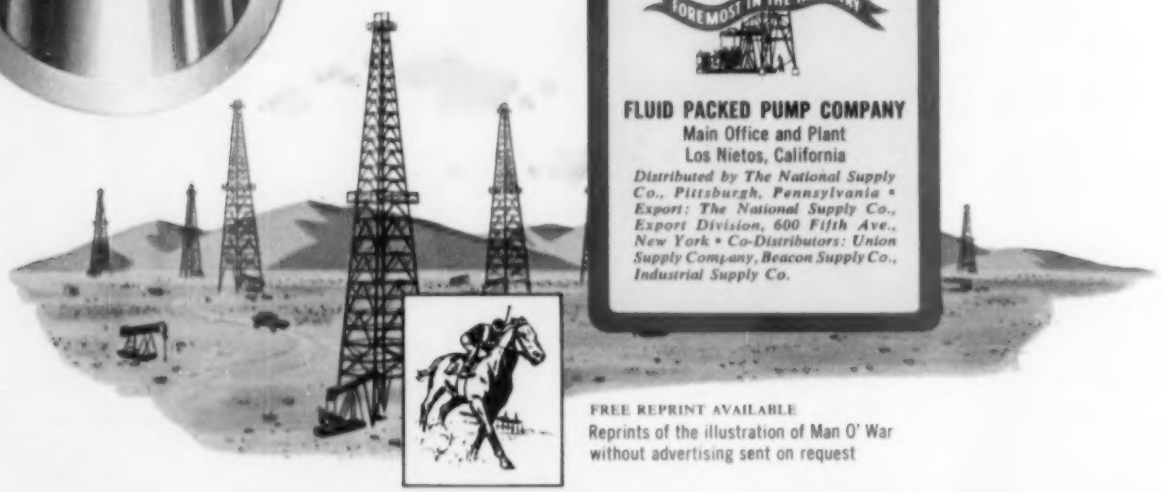
HARDENED AND HONED ONE PIECE PUMP BARRELS

Their design and general construction can, has and will be copied, but THIRTY YEARS OF EXPERIENCE and KNOW-HOW in this field of endeavor are the exclusive property of FLUID PACKED PUMP COMPANY.



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EQUIPMENT MEN . . . in the News

Weatherford Appoints Three District Managers

GARLAND DIGGS

Weatherford Oil Tool Co. has created three new districts to serve South Texas and has appointed a manager in each of the new districts.

Garland Diggs has been made sales manager of district five which will cover the area extending northwest between Aransas Pass and Port Lavaca, taking in Victoria and San Antonio. He will service the area out of Corpus Christi.

LEONARD DIXON

JAKE BRADLEY

Leonard Dixon is manager of district six which covers the area north of a line from Laredo to Corpus Christi to a line from Del Rio to San Antonio. He will also cover Corpus Christi.

Jake Bradley has been made manager of district seven which covers the lower Rio Grande Valley below a line from Kingsville to Laredo.

Orr is Southeastern Sales Manager for Hill, Hubbell

GEORGE ORR

The appointment of George Orr as southeastern district sales manager of Hill, Hubbell & Co., division of General Paint Corp., has been announced by M. M. Bowen, general manager and vice president of Hill, Hubbell & Co.

For 6 years Orr was with Columbia Gas System and before that he was corrosion engineer for United Fuel & Gas. Orr's territory includes West Virginia, Maryland, Virginia, Kentucky, Tennessee, North Carolina, Georgia, and Florida, with headquarters in Charleston, W. Va.

W. C. Norris Manufacturer Holds Annual Sales Meeting

Thirty field and key plant personnel attended the recent annual sales meeting of W. C. Norris Manufacturer, Inc., in Tulsa, according to an announcement by E. C. Bolger, company president:

First row: Buck Tolleson, Kilgore; Jack Getty, Shreveport; Paul Hagaman, assistant sales manager; Don Stewart, Midland; E. C. Bolger, president; G. W. Davidson, vice president, sales; Kenneth Hance, Salem; Art Miller, sales manager; and William L. Butler, executive vice president.

Second row: Hamp Brooke, Houston; Jack Schaff, Tulsa; Dan Coates, Ardmore; Ed Giles, Tulsa; Marvin Parker, Odessa; Clyde Sights, Evansville, Ind.; Archie Ethriedge, Oklahoma City; Le Roy Mitchell, Casper; Jere Whitaker, Fort Worth; Sonny Preis, Lafayette, La.; and M. E. McKelvey, Wichita Falls.

Third row: William R. Pierre, Tulsa; C. L. Snelling, Gulf Coast district manager; Cecil Fair, Great Bend; J. G. Russell, Oklahoma City; Red Preston, Wichita, Kans.; Doyle Bain, Corpus Christi; A. A. Hardy, chief engineer; Paul Colvard, Odessa; Kenneth Cook, Abilene; and Earl Johnson, assistant chief engineer.

Specialty Fabrication Is Announced by Glitsch

Fritz W. Glitsch & Sons, Inc., Dallas, has announced a new specialty-fabrication department for refineries and processing plants. The department will handle the design and fabrication of special kiln internals for cat-cracking units, reactor and regenerator beams and baffles, special piping, welding, steel components, and other equipment which must be engineered for weight and strength ratios or special construction.

The firm executes its customers' engineering requirements, from the rough-sketch stage into anything that is suited to forming, drawing, bending, or welding. The plant has facilities to work metals from heavy plate to sheet-metal gage.

Hale Appoints Rhodes As Sales Representative

T. R. RHODES

The appointment of T. R. Rhodes as sales representative has been announced by B. C. Hale, president of Hale Manufacturing Co., Tulsa. Rhodes' territory will include East Texas, South Arkansas, and North Louisiana. Hale Manufacturing makes and distributes pumping specialties and a newly introduced butterfly valve. Before joining Hale, Rhodes was a manufacturers' agent in West Texas, distributing transportation equipment to the petroleum industry in that area.

Byron Jackson Forms New Sales-Service Corporation

The sales and service operations for Byron Jackson oil tools and PB products are being handled under the name of Byron Jackson Tools, Inc. The formation of the new corporation was announced by E. S. Dulin, president of the Byron Jackson Division of Borg-Warner Corp. It was established to provide faster, more flexible operating procedures. The new corporation will not affect the activities of BJ Services, Inc., which is already a separate subsidiary of Borg-Warner.

Officers of Byron Jackson Tools, Inc. are: E. S. Dulin, president; Robert

Harcus, executive vice president; G. F. Nicolson, vice president and general manager; V. C. Horner, vice president and manager of sales; C. F. Vincent, vice president; Ross Barrett, secretary and treasurer; Franklin Sloff, assistant secretary and assistant treasurer.

Stone & Webster Opens New Houston Office

Stone & Webster Service Corp., New York, has opened an office in Houston, according to President Richard N. Benjamin.

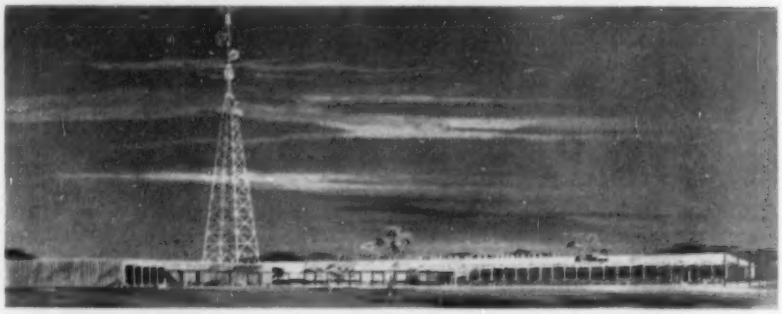
The Houston office will be under the direction of Paul R. Taylor, president of Industrial Gas Supply Corp., Houston, who is also a vice president of Stone & Webster Service Corp. Both organizations are subsidiaries of Stone & Webster, Inc., New York.

Delta Makes Graham Sales Manager, Pressure Vessels

Promotion of Arch L. Graham to sales manager of Delta Tank Manufacturing Co., Inc.'s, pressure vessel division has been announced by J. E. Ketner, executive vice president and general manager of the Baton Rouge firm.

Graham has served as general works manager of Delta's Baton Rouge plant since joining the company 2 years ago. He was superintendent of shop and new developments for General Welding Works prior to joining Delta in 1954. Earlier he was production coordinator and assistant to the vice president in charge of production for Wyatt Metal & Boiler Works.

Garrett Oil Tools Begins Office-Research Facility



Construction of this modern manufacturing plant and office building has begun in Longview, Tex., for Garrett Oil Tools, Inc., a division of U. S. Industries, Inc., it has been announced by H. U. Garrett, president of the firm.

The new tool plant, office structure, and experimental research and development center will occupy 75,000 sq. ft. of floor space, including 18,000 sq. ft. for offices and 57,000 sq. ft. for shop space. Completion of the project is expected around January 1957.

The separate experimental research and development buildings will be complete with their own machine shop. A 1,000-ft. test well with a 95-ft. derrick also is planned.

E. A. Gize, C. T. Pease Added to Procon Staff

Two process engineers, Edward A. Gize and Charles T. Pease, have been

E. A. GIZE

C. T. PEASE

added to the staff of Procon, Inc., according to Carl B. Whyte, president.

Gize was formerly with Sinclair Refining Co. as a technical field man on inspection and operating assignments. Pease came to Procon from Arkansas-Louisiana Gas Co., where he was a process engineer in the natural-gasoline division.

Hussey Heads Berkeley's Analog Computer Department

Berkeley Division of Beckman Instruments, Inc. has established a new analog computer department headed by Joseph L. Hussey, formerly assistant chief engineer computers. Thomas Allinson, division manager, stated that the new department is responsible for sales, installation, field engineering, design and development of special computer equipment.

Hussey has been with Beckman 4 years. Prior to that he was with Northrop Aviation Co.

Hussey's former research and devel-

This announcement is neither an offer nor a solicitation of an offer to buy these securities. The offer is made only by the Prospectus.

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with the expansion of its line of quality fatty nitrogen products, the

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Aliquats*: These fatty quaternaries combine excellent corrosion inhibiting qualities with bactericidal activity. They are used in secondary oil recovery, circulating water systems and cutting oil formulations.

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Diams*: These fatty trimethylene diamines are strongly alkaline and have high cationic activity. They are valuable in formulating corrosion inhibitors for crude oil production, transportation and storage. Their properties suggest many other interesting applications.

*Trade marks of General Mills

For more information on these four product lines, write Dearborn Chemical Company, Merchandise Mart Plaza, Chicago 54, Illinois for booklet, "Fatty Nitrogen Primer." A competent technical service staff is ready to work with you on specific problems.

CHEMICAL DIVISION OF General Mills
KANKAKEE, ILLINOIS

opment duties at Berkeley have been assumed by Alan MacLane.

Security Assigns Burris As West Texas Engineer

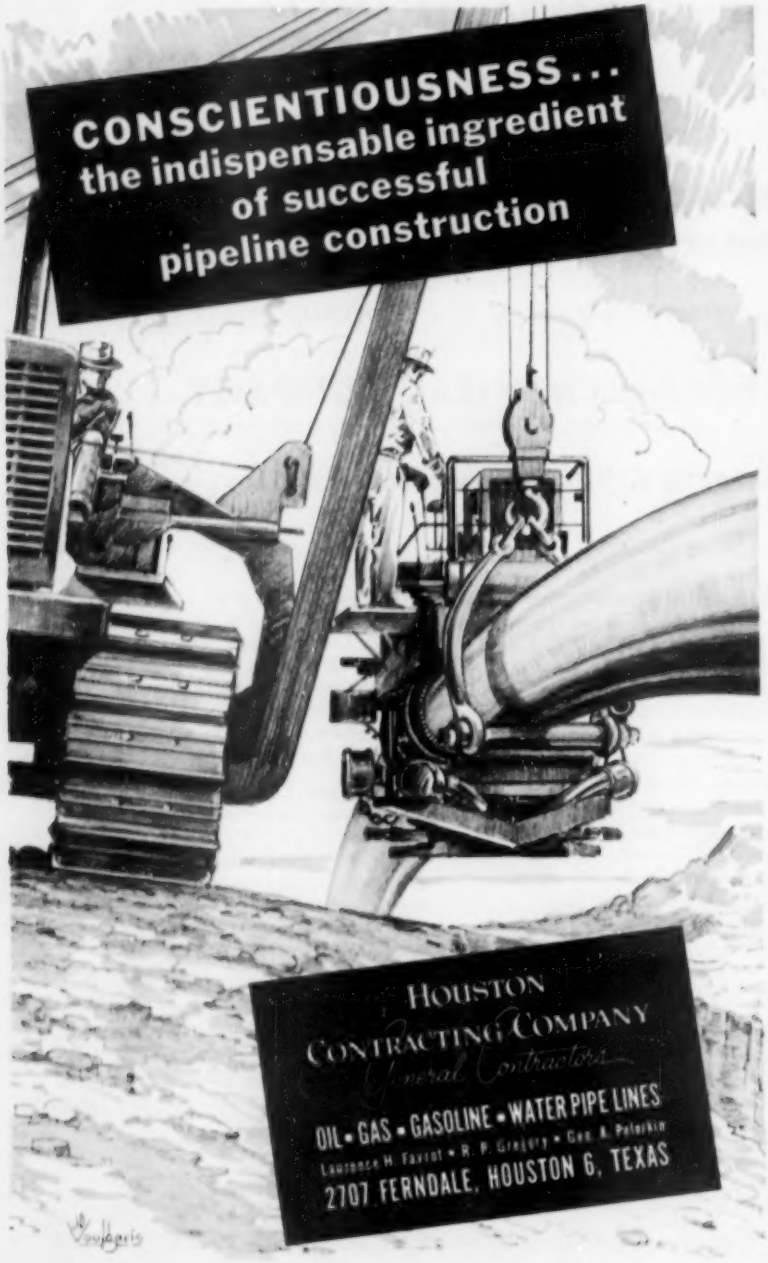
Assignment of Frank Burris as field engineer in the West Texas division has been announced by Ed Scarborough, assistant chief engineer for Security Engineering Division, one of the Dresser Industries.

Burris joined Security after 9 years as field engineer for another bit manufacturer.

Harbison-Fischer Opens Hobbs Factory Warehouse

Harbison-Fischer Manufacturing Co. of Fort Worth has opened a new factory warehouse in Hobbs, N. M. The facility will carry complete stocks of the company's line of subsurface oil-well pumps and related production equipment to supplement supply-store stocks in the area.

R. D. Faver and Jimmy Boggs, sales representatives, have been assigned to the new location, and Jimmy Cox is in charge of warehouse stocks. The branch will serve fields in Denver City, Tex., and Eunice, Lovington, and Artesia, N. M.



National Supply Appoints Division Tubular Manager

McCLENDON

Jess D. McClendon has been appointed tubular manager for the California division of The National Supply Co. He succeeds H. H. Clark who retired after 30 years of service with the company. McClendon joined National in 1925, working in the pipe yard at Taft, Calif. Later he served as store manager at the Bakersfield, Huntington Beach, Long Beach, and Venice stores, credit representative of the Los Angeles office, and supervisor of stores for the California division. His most recent position was that of assistant division sales manager.

Ajax Transfers Platt To Mid-Continent Area

Howard O. Platt, coordinator of sales and engineering for Ajax Iron Works, Corry, Pa., has been transferred to the company's Mid-Continent district with headquarters in Tulsa. Platt had been located in the California area for the past 18 months, coordinating sales and engineering work for the Ajax line of gas engines and pressure pumps.

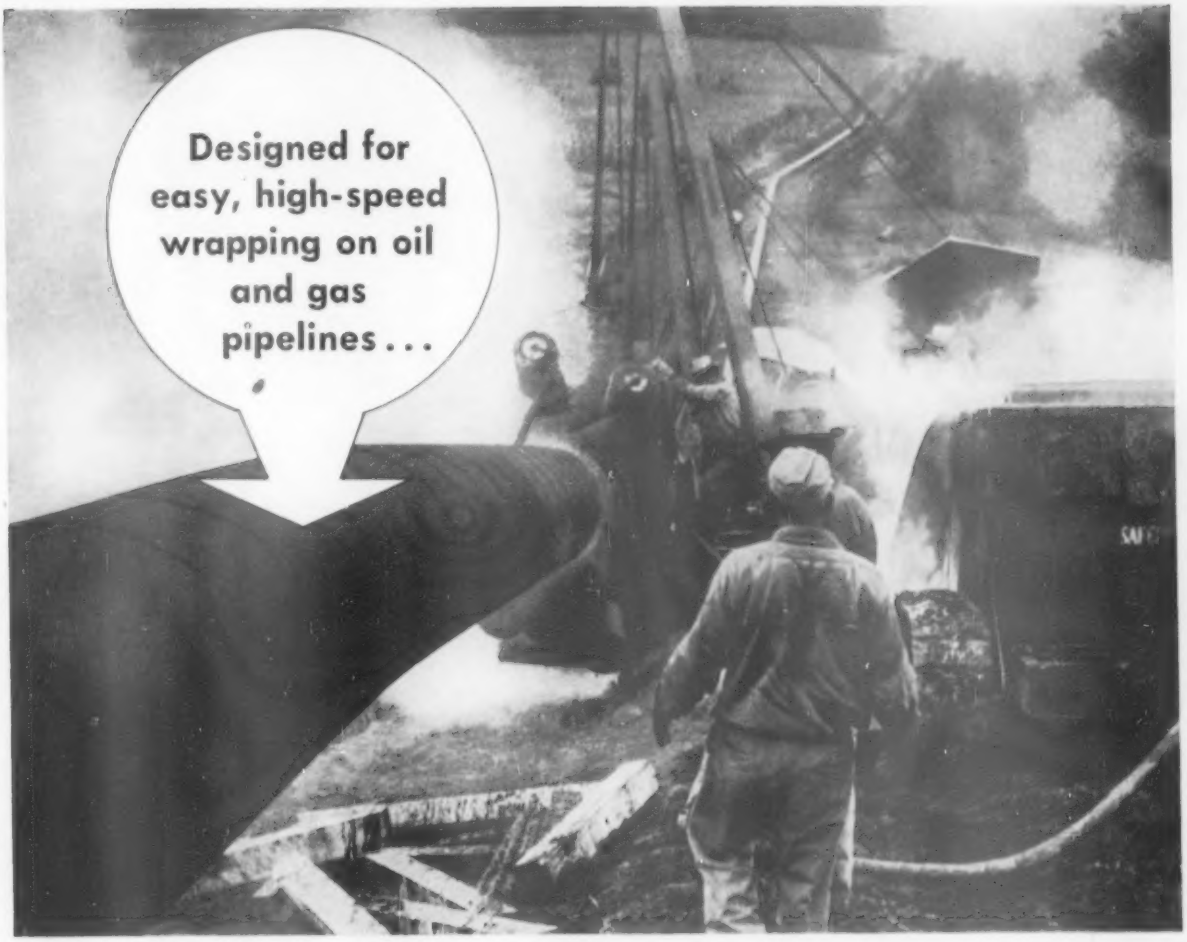
Schlumberger Names New Locations and Managers

Five Schlumberger Well Surveying Corp. locations have been established in Texas, Louisiana, and Nebraska.

The locations and their managers are: Andrews, Tex., R. G. Tefft; Carrizo Springs, Tex., P. R. Edling; Perryton, Tex., C. E. Tedrow; Franklin, La., George Broussard; and Kimball, Neb., W. F. Stephen.

Morris Heads SSC Northern Rocky Mountain Operations

Lauren G. Morris has moved to Billings, Mont., to take charge of Seismograph Service Corp.'s operations in the northern Rocky Mountain area, SSC president, G. H. Westby, has an-



Johns-Manville TRANSHIELD® ASBESTOS PIPE LINE FELT

goes on fast, restricts soil stress, cuts maintenance

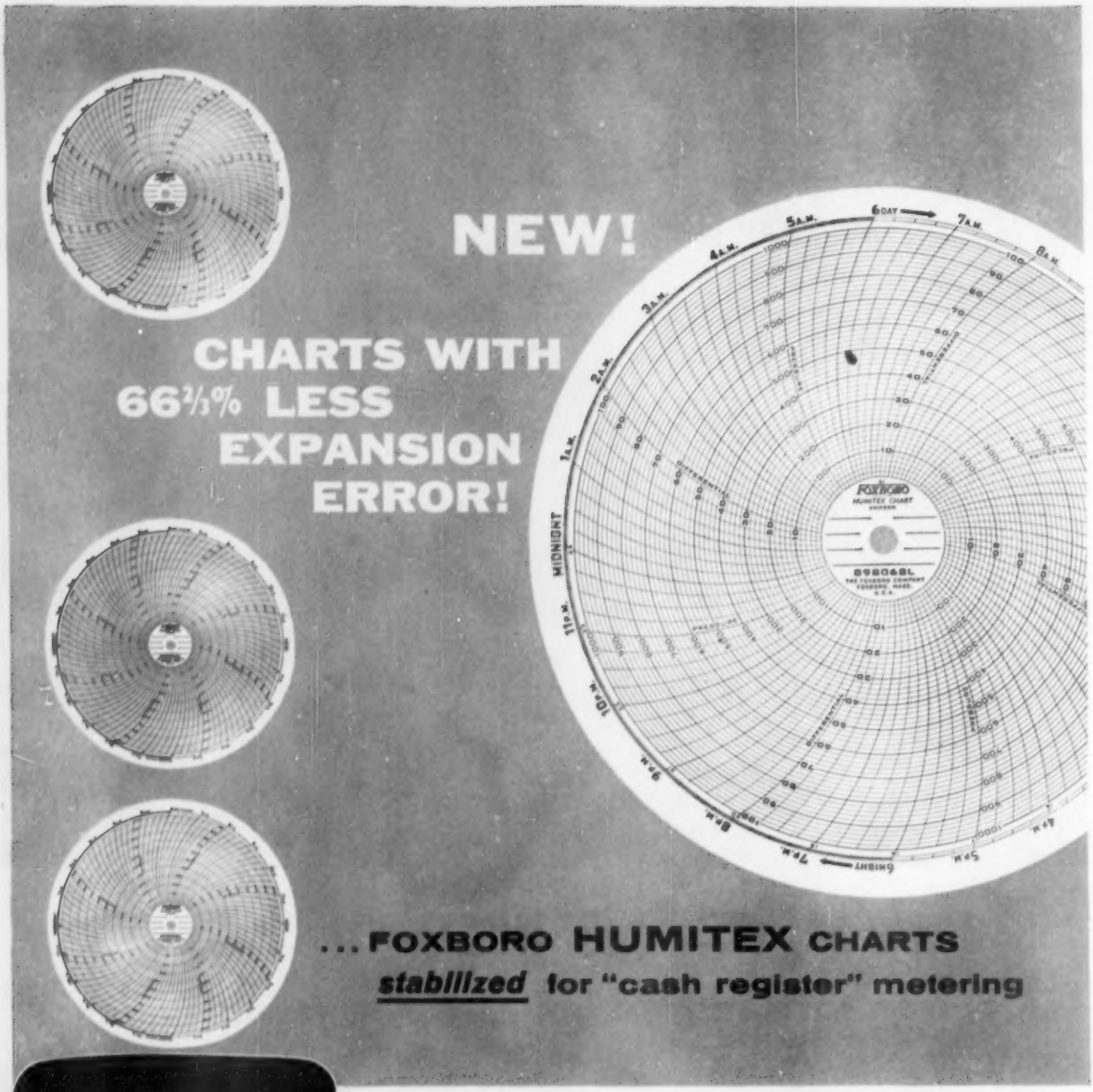
ON job after job, pipe line men have found that Transhield Asbestos Pipe Line Felt meets the need for an economical asbestos shield that is effective in average soil conditions.

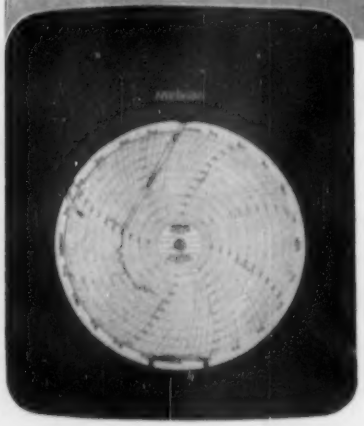
Contractors like Transhield because its special reinforcement makes it ideal for easy, high-speed application by modern machine methods. Consisting of a lightweight coal-tar-saturated asbestos felt, it is reinforced with continuous glass yarns parallel-spaced on ¼" centers. Transhield's light weight permits the use of 800-ft. rolls which increases application speeds since fewer stops for roll changes are required.

Transhield provides a continuous membrane between the pipe line enamel and the soil. It works effectively in preserving a continuous protective film of enamel on the pipe. During construction, it guards the enamel. After installation, it reduces the cold flow of the enamel, and acts as a surface barrier to restrict soil stress.

For further information write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, 565 Lakeshore Road East, Port Credit, Ontario.

Johns-Manville PRODUCTS FOR PIPE LINE PROTECTION





Like standard Foxboro Humitex Charts, these new *stabilized* charts have extra-high legibility too. Easy-to-read gray printing against the chart's smooth, white background brings out the full brilliance of Foxboro Recording Inks.

Here are the charts specifically designed to meet the high-accuracy requirements of "cash register" metering . . . Foxboro *stabilized* Humitex Charts. These advanced charts feature plastic-laminated paper — assure you *real* dimensional stability under the widest variations in temperature and humidity. In an extensive series of laboratory and field tests, Foxboro *stabilized* Humitex Charts were found to have only ¼ to ⅓ as much dimensional error as the highest grade of standard charts!

Foxboro *stabilized* Humitex Charts are your assurance of consistent, high-fidelity records — wherever you meter — wherever you compute. Try them at our expense. Write for samples and quotation. **The Foxboro Company, 607 Neponset Ave., Foxboro, Mass., U.S.A.**

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REG. U. S. PAT. OFF.

nounced. He replaces S. W. Fruehling who is slated to become manager of SSC's new affiliate company in Brazil.

With SSC since 1947, Morris served a number of years as party chief of a field unit in Montana and North Dakota. In 1954 he went to Calgary as SSC's party supervisor in charge of crews operating in Alberta, Saskatchewan, and the Northwest Territories.

Gardner-Denver Opens New Winnipeg Office

J. A. CAVERLY

Gardner-Denver Co. (Canada), Ltd. has opened a new district sales and service office in Winnipeg to better serve the Manitoba, western Ontario, and eastern Saskatchewan area.

The district manager in Winnipeg is J. A. Caverly. He has had extensive experience in Canada, and since 1948 has worked out of the general sales department in Quincy. R. M. Coleman will be field engineer, and M. C. Louwers, office manager.

The new quarters have office and warehouse space for large stocks of parts and machines. The complete line of products from factories at Quincy, Ill., Denver, and Brantford, Ont., will be distributed through the Winnipeg office.

Dewey Supply Opens New Oklahoma City Office

Dewey Supply Co., Tulsa, has opened a sales office in Oklahoma City. R. D. Winans has been selected as sales representative for the new office located in the First National Bank Building. Winans has been in the oil-field-supply business 15 years.

Dewey Supply has another sales office in Bartlesville, Okla. Four main stores are located in Alva, Dewey, Chickasha, and Okemah, Okla.

Lufkin Adds Hightower to Central Division Sales

Marion Hightower has been added to the Central division sales staff of Lufkin Foundry & Machine Co. He will headquarter in Hobbs, N. M., handling all sales and service on Lufkin oil-field equipment in New Mexico, as well as the Andrews, Denver City, and Seminole areas in West Texas.

Hightower's production experience includes Kansas, Oklahoma, and the Williston basin.

McCullough Makes Schaller Pacific Logging Manager

H. E. SCHALLER

Herman E. Schaller has been appointed logging manager of McCullough Tool Co.'s Pacific division, according to I. J. McCullough, company president.

Formerly in charge of Pacific division logging sales, Schaller will now have charge of all aspects of McCullough's radiation well-logging program in California. This will include supervision of field operations, procedures, training of personnel, log evaluation and continued assistance to the sales department in the analysis of logging techniques.

Schaller has served with the conservation committee of the California Oil Producers Association. The Texas Co., Eastman Oil Well Survey Co., and has been with McCullough 7 years.

D & S core barrels are
Faster, Better, More Economical
Field-proved and tested, D & S core barrels meet and surpass all oil field requirements. Quick core recoveries, and faster penetration mean more overall rig savings. D & S core barrels give connection every time and longer core runs. WRITE OR CALL TODAY! One of our sales engineers will call on you and explain our custom-services and equipment. Herein lie the real D & S advantages.
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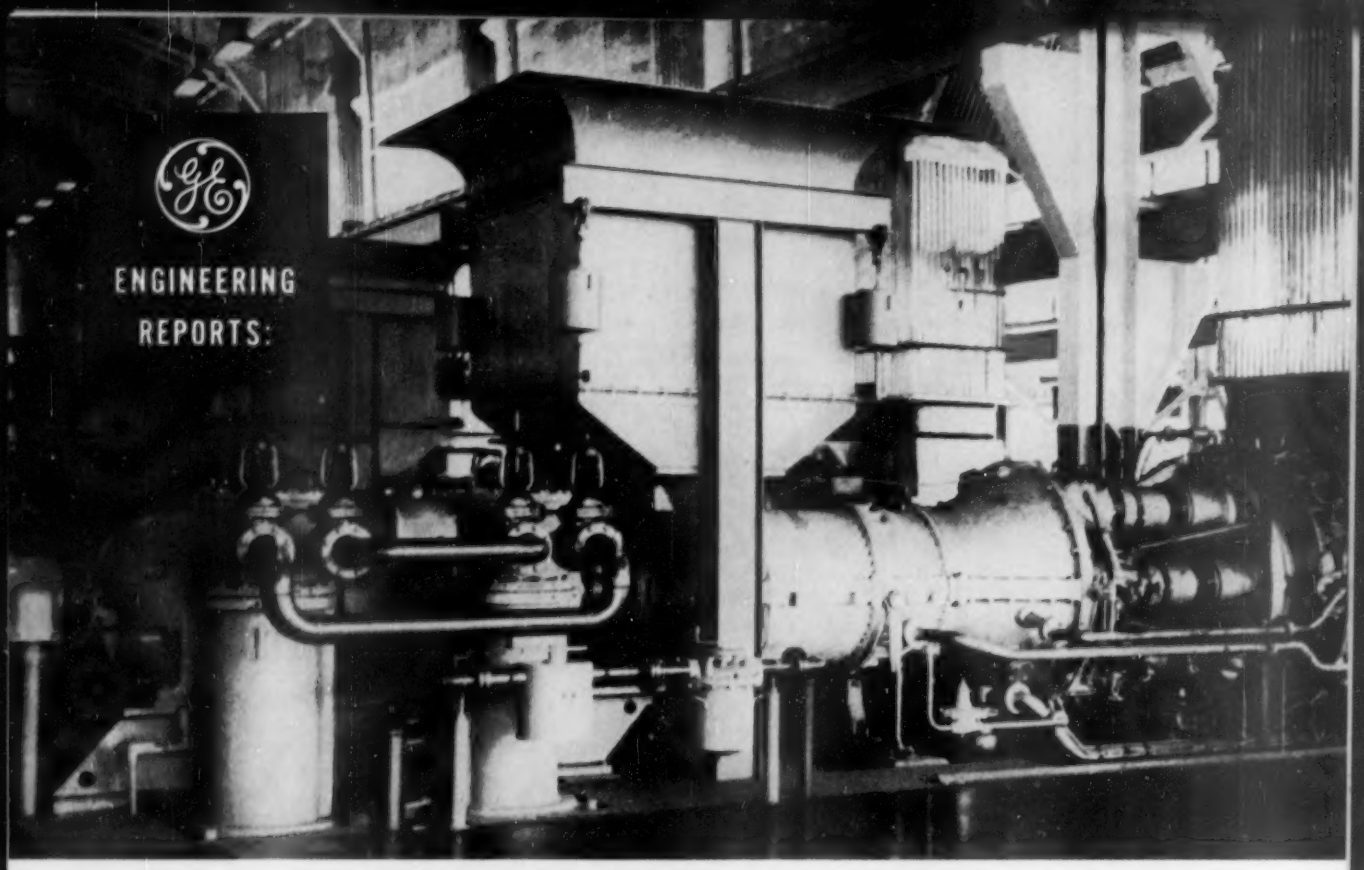
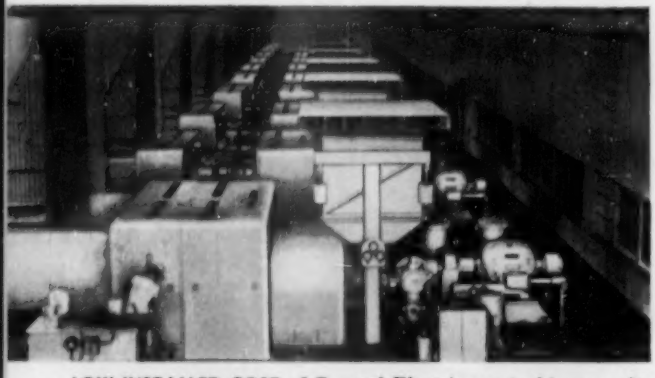
DIAMOND DRILLING EQUIPMENT
6210 NORTH CENTRAL EXPRESSWAY | DALLAS, TEXAS
OFFICES IN ALL PRINCIPAL OIL AREAS

"I still think we oughtta' pitch in and buy a TV set."



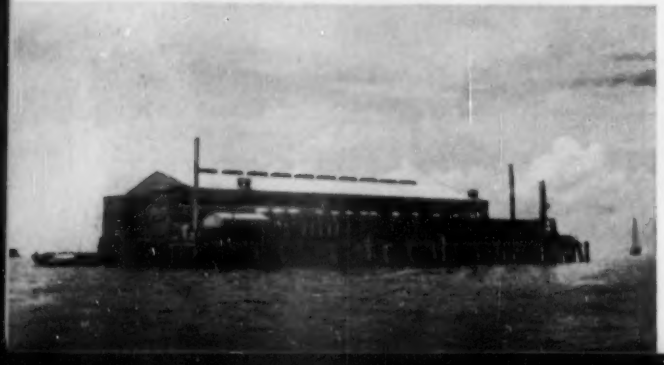
In first 13 months of operation at Lake Maracaibo...

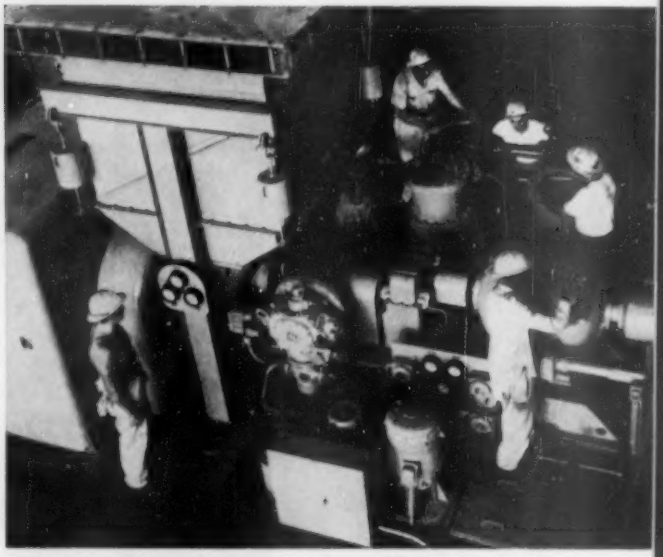
Creole Petroleum's log 89,000 hours



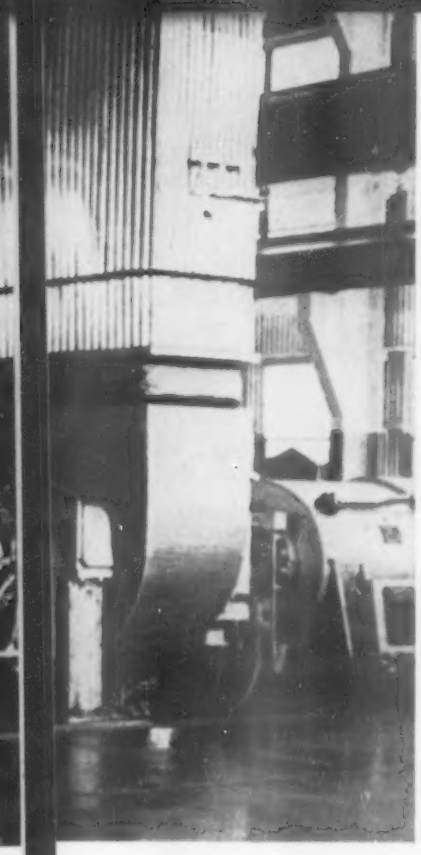
LOW INSTALLED COST of General Electric gas turbines results from ease of handling during installation. Gas turbine units up to 13,000 hp are self-contained, mounted on foundation bases which double as shipping skids.

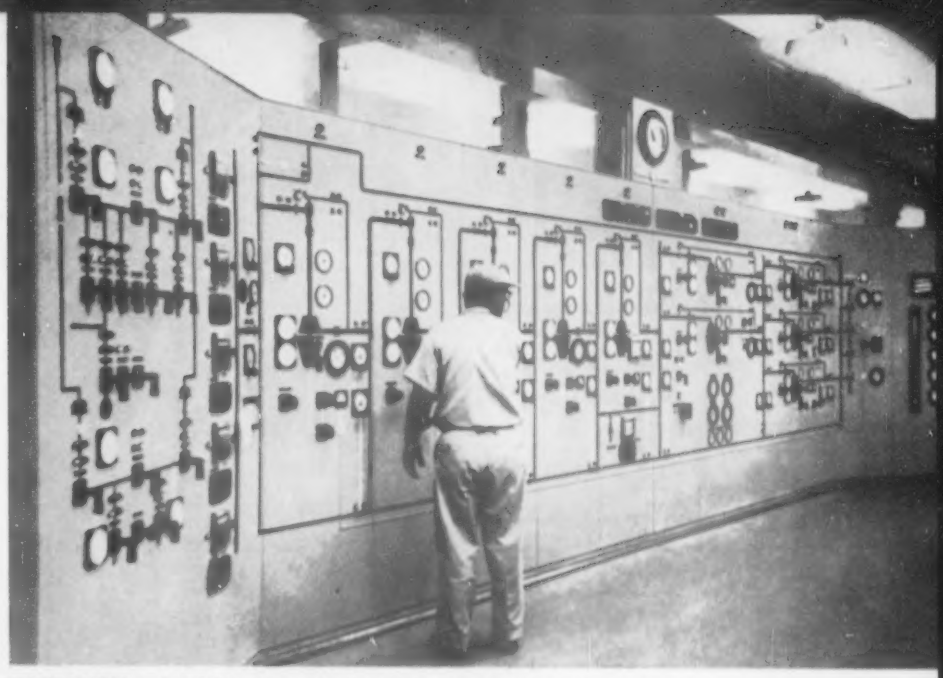
LIGHT WEIGHT AND LOW VIBRATION are essential to Creole installation, which is mounted on piers above 60 feet of water. General Electric gas turbines fill these requirements because components are compact with minimum vibration.





SYSTEM-ENGINEERED G-E gas turbines—shown here during installation—include fully integrated starter motors and assemblies. All ten turbine-compressor units in the Lake Maracaibo plant can be started and put on the line in about ½ hour.





CENTRALIZED CONTROL of practically all station functions is combined in main General Electric control panel. Turbines, compressors and valves are directed from this board.

SEMI-AUTOMATIC OPERATION of G-E gas turbines means a minimum of operating and supervisory expense. Need for separately mounted auxiliary pumps and blowers is eliminated because of completeness of units.

10 General Electric Gas Turbines —with an availability of 98%

Creole Petroleum operates their Tia Juana No. 1 Conservation Plant on a platform over Lake Maracaibo in Venezuela—in the midst of its offshore oil fields. Ten General Electric 6000-hp combustion gas turbines —heart of the plant—power centrifugal reinjection compressors to conserve the gas and to increase the yield from these gigantic fields. This installation represents the largest concentration of gas-turbine horsepower in the world.

IN THEIR FIRST 13 MONTHS of operation, ten G-E units operated a total of more than 89,000 hours. Except for planned maintenance, the platform has never had to be shut down due to a gas-turbine outage, and availability has averaged 98% for the ten General Electric gas turbines. When sufficient gas has been available, the plant has *consistently* re-injected more than its planned capacity of 137 million standard cubic feet per day. During one week, the platform averaged 170.8 million cubic feet per day.

THE SUCCESS of this unique installation resulted from the close co-operation between Creole, their consultants —Esso Research and Engineering for process engineering and Brown and Root, Inc., for design engineering and construction—and G-E engineers. Creole's installation is an outstanding example of Petroleum Industry enterprise and represents a new concept in oil field pressure maintenance.

Creole is also a good example of how G-E engineering services can help you and your consulting engineer plan and install an engineered electrical system for your specific need. For more information about General Electric engineering services and electrical equipment, contact your nearest G-E Apparatus Sales representative and write for Bulletin GEA-5962 to General Electric Co., Section 661-53, Schenectady 5, N. Y.

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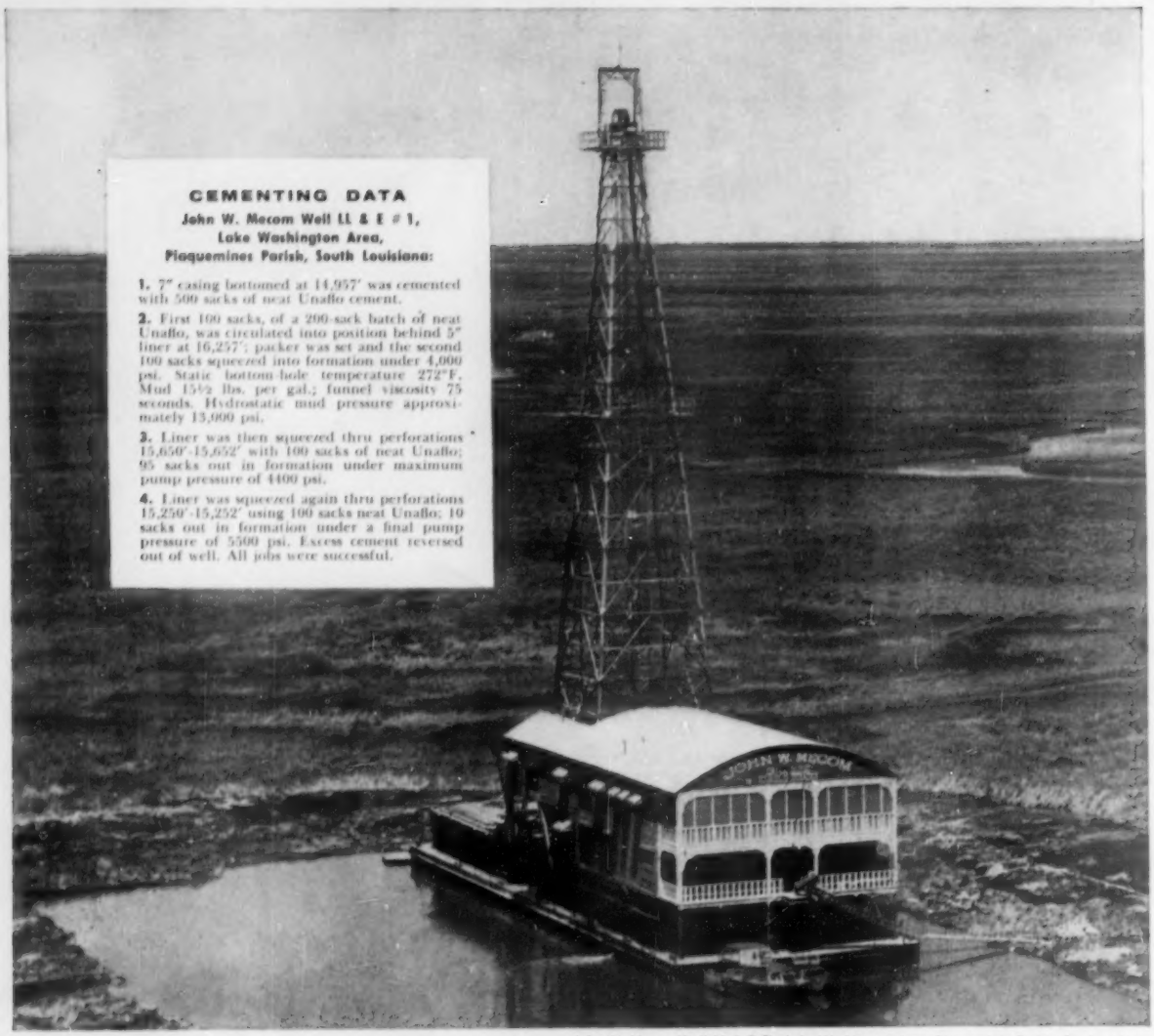
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3. Liner was then squeezed thru perforations 15,650'-15,652' with 100 sacks of neat Unaflo; 95 sacks out in formation under maximum pump pressure of 4400 psi.
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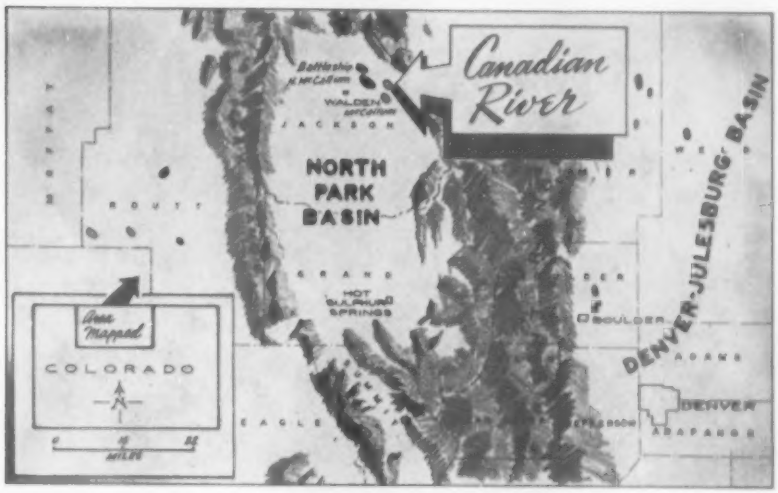

Sky-high basin in Colorado proves theory that

Oil Is Where You Find It

by Frank J. Gardner

THERE'S an oil bowl perched high up in Colorado's mountains that warrants a lot more attention than it's getting. It sits at an altitude of 8,200 ft., cradled between the Front Range and Park Range mountains. Some wags have suggested it might be easier to tunnel through from Fort Collins and tap the oil from there, than to drill at such altitudes. But oil finders, being the hardy souls they are, have uncovered two good oil fields, two noncommercial pools, and now a three-pay gas field—the first discovery of combustible gas in the North Park basin.

Unexpected gas . . . Today, the operations of Cabeen Exploration Corp. on a Continental Oil Co. farmout are holding the North Park spotlight. These operators discovered the Canadian River field early this year. The first strike, 1-A Blevins, (Section 11-9n-78w) flowed 6 million cubic feet of gas per day from 22 ft. of Muddy-Upper Cretaceous sand at 1,540 ft., to give North Park basin its first combustible-gas production. Completion of the discovery was not exactly as planned originally by the operators, for the pay was found at a shallower depth than expected, and high gas pressures that were just as unexpected caused a blowout; Cabeen solved the problem by cementing and perforating the drill pipe for completion in the Muddy.

Cabeen's second well, the 2-A Blevins, (Section 3-9n-78w) was completed as a dual producer from the Dakota sand at 1,704-24 ft. and the Lakota at 1,768-93 and 1,803-28 ft., with a potential of 21 million cubic feet of gas per day, opening two new pay zones for the field. Net pay in the well is 90 ft.

In a search for a hoped-for oil rim, the operators drilled a third test, the 1-B Blevins, too far downstructure and got a dry hole for their trouble; it was abandoned recently at 2,253 ft. But Cabeen believes it will find commercial oil at Canadian River, and other stepouts are in the offing.

And unusual shows . . . The new interest in North Park basin actuallly began as far back as 1952, when M. E. Davis made headlines with his 1 State wildcat on the Coalmont anticline in the southwestern part of the basin (Section 36-7n-81w). This turned out to be a dry hole and was abandoned in April 1953 in Benton-Lower Cretaceous at 6,920 ft. But before it died, the wildcat made news by flowing 42° oil at rates up to 35 bbl. per hour from the First Frontier-Benton (Upper Cretaceous) sand at 6,884-6,908 ft. It could not be completed because of severe lost-circulation troubles.

This wildcat riveted attention on North Park for the first time in two decades. Way back in 1926, Continental had found oil and CO_2 gas in North McCallum field, with production coming from Dakota sand at 5,113 ft. Later wells produced from the Lakota, and from the Morrison-Jurassic. Good shows were also found in the Sundance-Jurassic. Another CO_2-distillate field was discovered on the South McCallum anticline, but it has been shut in since discovery. These two fields, located on sharply folded, long narrow anticlines with closures up to 2,000 ft., have produced nearly 2 million barrels of oil to date.

Plus important reserves . . . In 1954, North Park basin was in the news again when Lion Oil Co. 1 Dwinell opened Battleship field, 2 miles north of Continental's North McCallum field. This discovery pumped 105 bbl. per day from Dakota sand at 4,561 ft. and was free of the troublesome CO_2 gas that had plagued the McCallum wells. Production declined, and Lion perforated the Lakota at 4,650 ft., recompleting the well for 500 bbl. daily from both formations. Production from the field is now about 1,100 bbl. daily, and indications are that Lion has found reserves of importance at Battleship. Besides the Dakota and Lakota, the First Frontier is also believed to harbor oil.

The experiences of these operators are typical of what you might run into in one of these small intermontane basins. Accessibility is of course the number one problem. This along with weather extremes, thin air, and difficult drilling add up to expensive wells —a 2,000-ft. test can cost as much as $50,000. Cabeen employed surface geology, photogeology, and finally seismic surveys as a firm check on structure. The subsurface rocks are steeply folded and highly faulted, and drilling a straight hole is no easy matter. But the shallow production, the multiplicity of pays (at least five can be counted on), and the economies that will come with experience should continue to lure the wildcatter.

Will lead to campaign . . . The important thing is that Continental, Lion, and Cabeen have shown the industry that small intermontane basins will pay off. You can look for a lot of new wildcats all over North Park in the next year or two. And you can look for even more enterprising wildcat campaigns in similar basins at Middle Park, South Park, and Wet Mountain Valley.

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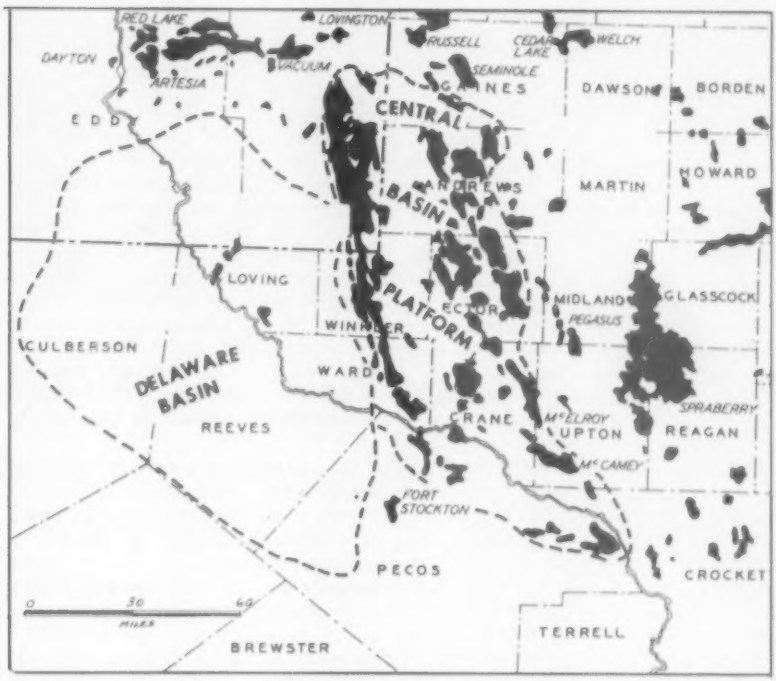


GEOPHYSICAL WORK in the Delaware basin is exceptionally difficult to interpret because of rapid changes in velocity and the complex changes in lithology. Fig. 1.

Seismic characteristics difficult but . . .

Prepared Plans of Attack Promise Delaware Basin Rewards

by W. A. McFadden, Jr.

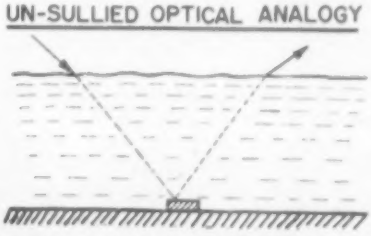
THE geophysical characteristics of the Delaware basin can be oversimplified in one word—difficult.

Perhaps it would be more accurate to define the seismic characteristics as difficult. This does not imply that magnetic and gravity operations are particularly easy in the Delaware basin. But they are not loaded with the extreme difficulties with which seismic prospecting, with but very few exceptions, is plagued.

Discussion and detailed descriptions of all the combinations and permutations of field procedure tried in the basin will not be attempted. And if you are expecting to read how to get good records any time any place in the Delaware basin, you are in the right business. You're a born optimist.

Instead, discussion will be confined to suggesting some plans of attack.

Seismic problems . . . Normal seismic prospecting, if there is such an operation, can be compared to the unsullied optical analogy of Fig. 2, where a coin is shown at the bottom of a pan of water. Light enters the water on the left, strikes the coin, and we see the reflection on the right without any difficulty.



NORMAL SEISMIC PROSPECTING in areas of good reflection quality is comparable to this optical analogy. The position of the reflecting coin can be determined easily. (After J. P. Woods.) Fig. 2.

Fig. 3 is, unfortunately, at least representative of seismic prospecting in the Delaware basin. If we substitute for the broken beer bottles the post-Delaware section, this diagram takes on a much less fanciful aspect.

If you are amused by Fig. 3, you should realize that in wells spaced at half-mile intervals the average dip between wells on the base of the Quaternary fill has been observed to approach 45°. At this 45° contact the seismic velocity jumps from approximately 5,000 ft. per second to some 19,000 ft. per second. It started at about 3,500 ft. per second at the surface.

After crossing this type of interface —which fortunately doesn't occur at every place but may occur at any place —the seismic energy must penetrate the evaporite section in the post-Delaware Permian with its many, and probably many hundreds, of sharp velocity contrasts. This is a beautiful section for reverberations.

Thus far only the outgoing energy has been considered. To be useful for seismic prospecting it must come back in recognizable and reproducible form.

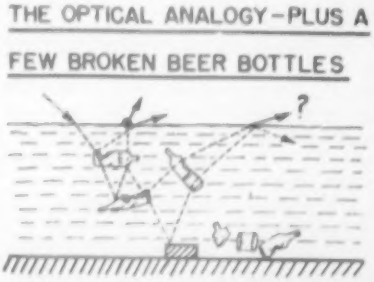
It is not surprising, then, that so many Delaware basin records are wonderful examples of noise, only slightly disturbed by reflections.

In summary, the lithologically erratic post-Delaware section of the Permian and the Quaternary fill are blamed for the major share of the seismic difficulties in the basin.

Industry-wide distribution of data and experience will, eventually, be of great assistance in solving these difficulties.

When operating in the basin you should obtain velocity information in all possible drill holes, regardless of depth. Remember that the four-to-one velocity contrast with the 45° dip may be less than 1,000 ft. deep.

Usable data . . . It happens that there are areas of limited extent in the Del-



PROSPECTING in the Delaware basin is similar to this example. The broken bottles represent the post-Delaware section that makes it almost impossible to obtain and identify seismic reflections. (After J. P. Woods.) Fig. 3.

ware basin in which usable—not good, but usable—reflections can be obtained. These areas are commended to your attention as areas to be thoroughly detailed by the seismograph; they may yield some clues to the solution of the larger, and much more frequent, impossible areas.

When you happen across one of these better-record areas, or hear about one, have your geophysicist beg, borrow or liberate all available velocity information. It will be advisable to go to the extent of buying it, if necessary. Get the shallow velocity data, particularly.

Then have the geophysicist run the deep swab on your geologist, and, preferably together, they should correlate all of the geologic and seismic information. They should not forget that record quality is a form of seismic information.

If this combination of geologic and seismic talent comes up with data contrary to the statement that the post-Delaware sections are responsible for the seismic difficulties, it may be cause for rejoicing.

If this statement should be correct, it may not be possible to get past the broken bottles in these sections.

You can try to look through the frosted glass on your office door with a very bright light—or 36 small ones—and with very monochromatic or very polychromatic filters, and you won't see very much.

Unless you use X-ray and appropriate equipment.

New techniques . . . The industry is gaining experience in the use of the higher-frequency seismic techniques. Talk to your theoretical people. See what they think of this approach. Perhaps they can come up with some ideas that are worth trying.

The Thumper

In the realm of the statistical approach the Thumper has been used to attack the problems of the Delaware basin. This technique uses the relatively minute signal energies produced by a dropping weight. The reflected signals, being in phase, tend to be built up by repeated drops, while the noise, at random phase angles, tends to cancel. On paper this approach is good. Think about it. See if you can transfer the paper results to recording paper.

It seems to be the consensus that the Thumper has produced results no better, nor any worse, than more conventional methods. This technique deserves further extensive, well-planned and well-directed use in the Delaware basin.

Recent seismic refraction work has located a producing well in the basin.

The erratic sections above the Delaware may not bother you so much with refraction shooting, particularly when you record your spreads from both directions to cancel differences in shallow velocities under shot and detector positions.

Lack of structural relief at the top of the Delaware will bother you, though. Presently producing fields from the Delaware sand show structural relief less than the resolving power of the reflection method. Such structures may not even show as flattenings on refraction maps.

And deep penetration may be difficult to impossible because of the seismic velocity inversion below the Delaware. If you are considering a refraction survey, get all possible deep velocity data in your area of interest before your plans are too advanced.

But discuss any reasonable seismic technique with your geophysical staff or with your contractor if you are considering shooting in the Delaware basin. If you think it is a practicable technique, don't take no for an answer. Not the first time, anyway.

Gravity and Magnetic Surveys

Recall that the comparatively near-surface lithology has been blamed for the seismic troubles in the basin. For the sake of argument, assume this to be true and consider some approach that will ignore the near-surface.

Consider the gravity meter and the magnetometer.

Gravity and magnetic surveys should be run with the utmost practicable accuracy as to observation; computations should be made and checked with equal care.

This recommendation applies whether you are running, purchasing, or trading surveys. You won't normally be so particular when swabbing.

Also, be certain of sufficient density of stations. In the Delaware basin, traversing roads and trails is not sufficient. You should occupy at least corners and centers of sections, and quite possibly corners, quarter corners, and centers.

When making airborne magnetometer surveys, place your lines at approximately 1-mile intervals and the tie lines as suggested by your contractor.

During the planning stage, discuss your gravity and magnetic surveys with your geophysicist or contractor. You'll find he wants to provide you with the best possible surveys.

Magnetic surveys . . . Now, return to the near-surface problems in the Delaware basin.

It is usually reasonable to assume that the magnetic picture is the same as it would be if the sediments were not present.

This is subject to the qualification, particularly in the Delaware basin, that immediate surface anomalies may affect magnetic readings. Such anomalies usually can be recognized by their appearance which betrays their surface origin. They do not appear on airborne surveys.

Magnetic anomalies are caused by inhomogeneities in the basement rocks. That is, by intrabasement contrasts or by relief on the top of the basement. The former are considered regional anomalies. The latter are residual anomalies—the ones you are looking for.

It is possible now to make reasonably accurate computations of depth to basement rocks from magnetic maps. It will not, generally, be possible to prepare a contour map on the basement surface. But in the Delaware basin such computations will be of interest as checks against your subsurface estimates of depths to basement.

Preparation of magnetic residual maps closely parallels that of gravity maps.

Gravity work . . . In contrast to the magnetometer, the gravity meter is influenced by the sedimentary section. The regional anomalies are of basement origin.

Density contrasts in the sediments above the Delaware section are to be expected, and are apparent on gravity maps, particularly near the Reeves-Pecos county line, and in Lea County. These are recognized by their small size, often indicated by only one station, even where station density is high. Checking these "off" stations usually

THE AUTHOR

W. A. McFadden, Jr., is a consulting geophysicist and geologist, with offices in Midland. He was graduated in geology from University of California in 1936 and took 1 year of graduate study before joining Standard of California in 1937. Following 4 years of seismic and surface geological work, he was transferred to Standard of Texas in 1941, where he had assignments in the geological and geophysical departments. McFadden was in charge of geophysical operations in West Texas when he resigned in late 1952. After spending 1953 in contract geophysical work in the Rocky Mountain region, he established a consulting office in geology and geophysics in Dallas in 1954. He has recently moved that office to Midland.

This paper was originally presented at the first exploration meeting of the Permian Basin Geophysical Society and the West Texas Geological Society, Midland, Tex.

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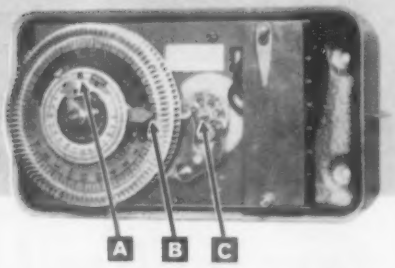

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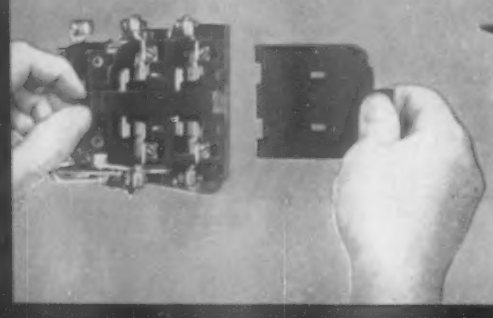

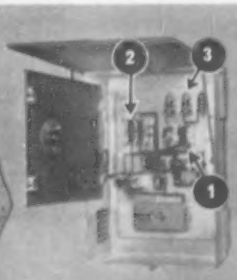

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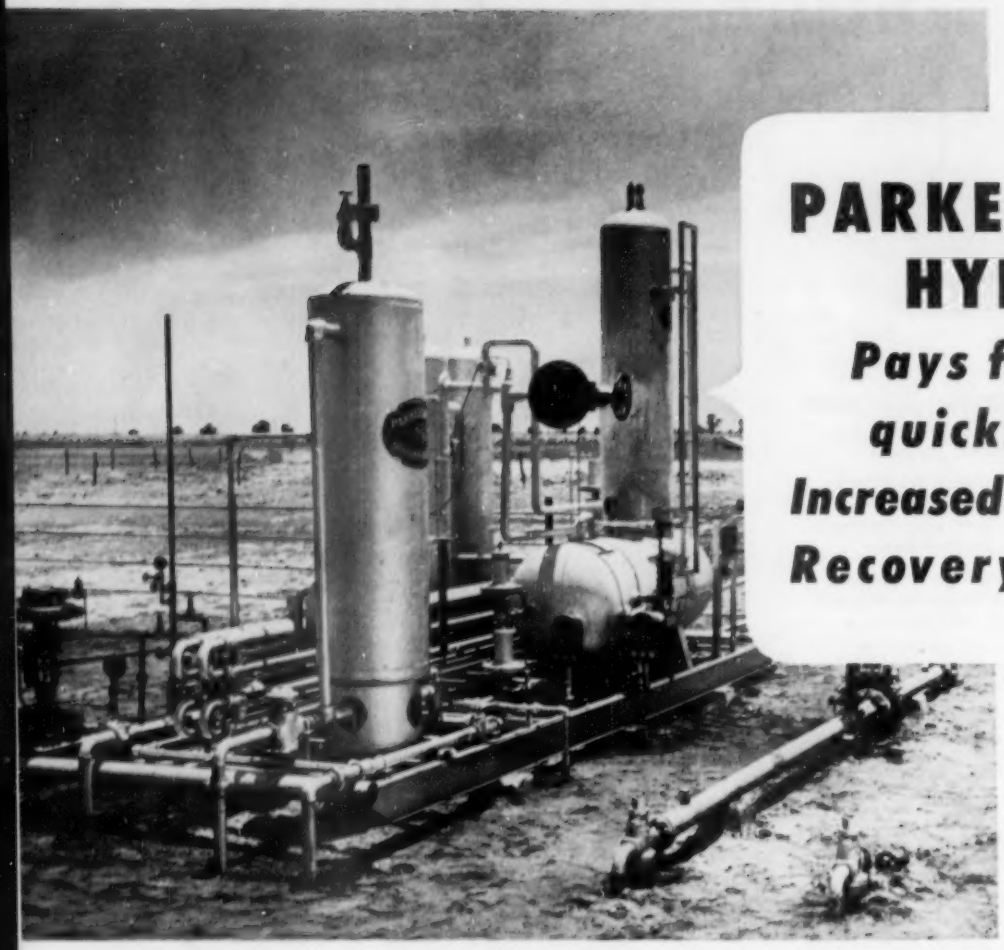

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finds them correct, confirming the small size and therefore the shallow source of the anomaly.

The structural interpretation of magnetic or gravity data usually involves the removal of regional effects.

With magnetics it is hoped that this removal may leave the locations of topographic highs on the basement surface. If they are linear, they may be fault scarps.

In the case of gravity, possibly removal of regional effects will reveal structures that have placed deeper, more dense sediments above their normal regional position.

The problem of separating regional from residual effects is incapable of exact mathematical solution, regardless of the quality or quantity of the magnetic or gravity data. This lack of a unique solution for regional is common to all measurements of potential field, of which gravity and magnetic observations are examples.

This being true, the method of removing regional depends upon the ability, experience, and judgment of the geophysicist deciding upon the method of removal.

The residual map, upon which you are likely to base important decisions, depends to an equal extent upon the geophysicist, for the method of removal of regional determines the residual map.

If you are interested in the problems of removing regional effects, you should read "Regionals, Residuals and Structures" by L. L. Nettleton in Geophysics, January 1954.

Modern computer techniques permit solutions for regional that are more intricate and laborious than formerly were feasible. But they do not provide that impossible exact solution for regional.

Whether you use punch cards and a digital computer, or a pencil and profile paper, judgment determines the residual map obtained.

In removing regional, another problem is encountered that can best be solved by the combined geological-geophysical team. By discussing the types and depths of structures expected—and therefore the types of anomalies to be expected—the geologist can combine his judgment with that of the geophysicist.

Assume that magnetic and/or (preferably and) gravity residual maps have been prepared. These maps will have many anomalies, often graded in the order of preference of the interpreter—again a matter of judgment. It is not possible to d e t e r m i n e specifically which, if any, of these gravimetric or magnetic anomalies are indications of structures that may produce oil.

Gravity anomalies and oil production . . . It is common knowledge, that on the northwestern shelf in Lea County, New Mexico, there is a very useful correspondence between residual gravity anomalies and producing structures. The most noted example is Denton.

There is every reason to expect this correspondence—as to pre-Pennsylvanian rocks—to extend southward into the Delaware basin.

It might be quite instructive to start with a residual gravity map of a large portion of Lea County on the northwestern shelf and to outline in chronological order the fields as they were discovered. As this is done, take time to predict where the next one will fall.

Then you will have posted your Delaware basin gravity and magnetic maps to date with producing fields. Keep these maps forward in your cabinet and in your mind. Don't let a pattern one day develop without your being aware of it.

If you have the facilities, or wish to buy the service, you may want to prepare gravity residual maps based on grids of various diameters, resulting in maps which are at least roughly selective as to depth. This is another facet of the empirical approach suggested above.

Depths in the Delaware basin are very considerable for pre-Pennsylvanian exploration on the basis of gravity and magnetics. Perhaps you can't reasonably expect management to be persuaded to wildcat to such depths on this basis.

But start a study that may, and probably will, pay off when more is known about the geophysics of the Delaware basin. Remember that gravity and magnetic data are not abnormally expensive to obtain in the basin. Nor are they abnormally difficult to interpret.

Don't expect to find a Denton this year. But don't overlook the possibility.

Think about the Delaware basin, whether you are a geologist or a geophysicist or management, and particularly if you are management. Think about it in terms of the oil that should be there. The oil which must be assumed there until the contrary is conclusively proved.

And that will take a lot of drilling.

Let the geologist and the geophysicist work out their common problems over logs and records, over the drafting table, and over coffee—and with management.

Perhaps, then, your group will be on top of the problem when that big one comes in in the Delaware.

And it will.

EXPLORATION HIGHLIGHTS

APPALACHIAN

EASTERN KENTUCKY

United Fuel Gas Co. has completed a good well at its 61 Kentland Coal & Coke located on Morgan Branch in the Pike County sector of Big Sandy gas field. At an elevation of 805 ft. Mississippian Big lime was topped at 1,978 ft., Berea grit at 2,887 ft. and Devonian black shale at 3,006 ft. Gas from the shale and Berea tested at the rate of 1,391,000 cu. ft. of gas daily at a total depth of 3,851 ft. A 72-hour rock pressure test showed 555 lb.

On Shoulder Blade Creek in Breathitt County, Mrs. Ada Letton has completed 1 Kelsey Anderson as a Big Six (Silurian) gas producer. At a total depth of 1,891 ft., well flowed gas at the rate of 273,000 cu. ft. daily with a 68-hour rock pressure of 412 pounds.

OHIO

An oil pool for the northeast corner of Granger Township, Medina County, is now indicated with the completion of a ½-mile stepout by Preston Oil Co. on 1 H. C. Brenneman, Lot 81. Red Clinton at 3,438-66 ft. and white at 3,471-91 ft. had shows that gaged 74 bbl in a 24-hour test after fracturing.

● A second gasser for Central Knox Township, Holmes County, was completed by Diamond Oil & Gas on 1 Paul Wrinkle, Section 17. Clinton at 2,959-72 ft. gaged 950,000 cu. ft. natural.

● The third Clinton producer in Marne pool was good for 232 bbl. after fracturing. Completed by Preston Oil Co. on 2 J. L. Mason, Lot 5, Madison Township, Licking County. Clinton was logged at 2,574-2,607 ft.

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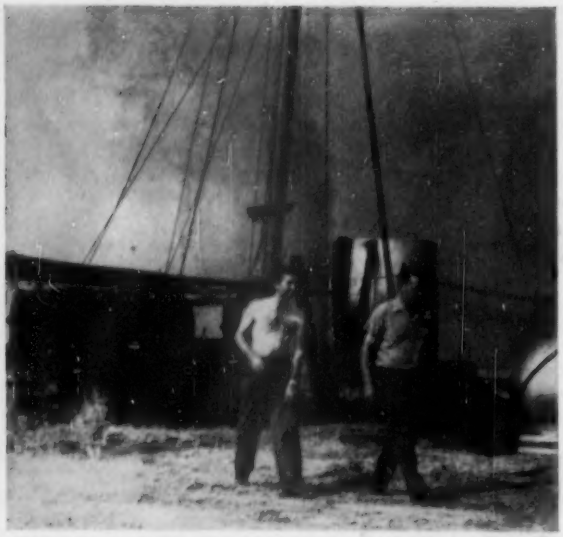
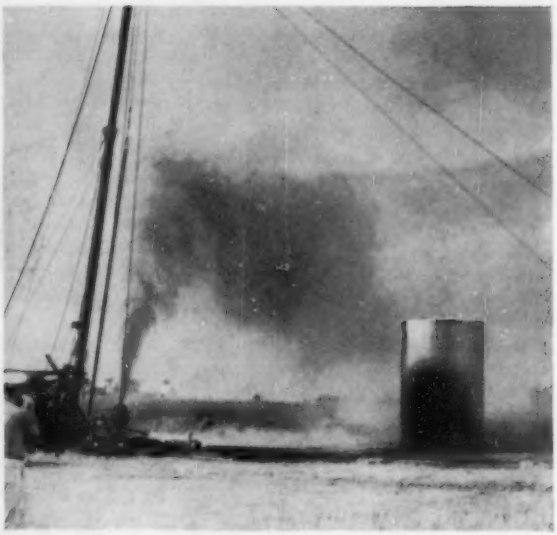


EARNEST E. SPENCER, Salem, Ill., a member of the spudder crew, leave the Mrs. Katherine Lundy well in the Coles-Douglas area after pressure blew the swab into the wellhead.



OIL SPRAYED over the field located southwest of Arcola in the northern part of the Illinois basin when closing off was prevented. Photos courtesy Arcola (Ill.) Record-Herald.

Coles-Douglas Area Leads Illinois Development

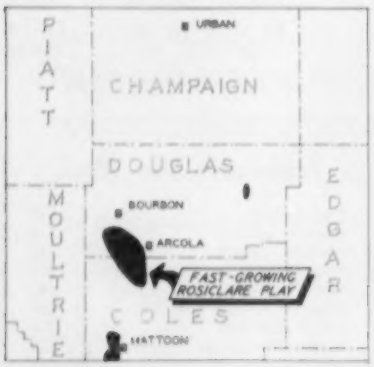
ONE of Illinois' most active development areas this year is on the Coles-Douglas County line, southwest of Arcola in the northern part of the Illinois basin. During the last week of June eight new oil wells were added to the fast-moving development program.

Reports from the area state that eight rigs are working the area. Production is from the Rosiclare lime. The score for the January-June 30 period for Coles County is 62 oil wells, 5 gas wells, and 47 dry holes. Douglas County, which only was opened to production last year, has 22 oil, 2 gas, and 25 dry holes to its credit this year. These figures do not include the four wildcat discoveries and 14 dry wildcat tests drilled in Coles; and the two oil strikes and 27 dry wildcat holes drilled in Douglas County.

In addition to drilling in the Arcola area, the Cooks Mills region to the southwest is also cutting in on the share.

Marketing troubles have caused proration of oil purchases to 50 bbl. per well per day. Oil was selling for $2.90 per bbl. the week of June 21. Kenland Oil Co. is taking the oil that is connected to their gathering line in the Cooks Mills area. There are reports of a gathering installation going in southwest of Arcola for further outlet. Two 1,500-bbl. storage tanks have been built at the pumping station near Route 45, north of Mattoon.

The wells in this area are all good ones. One in the Bourbon area had 25 ft. saturation. Some wells flowed as much as 1,000 bbl. per day. The pay is a soft, porous sand at shallow depths of around 1,600 ft.



The Coles-Douglas County area in central Illinois has taken over the development news in the Illinois basin. A fast-moving Rosiclare lime drilling campaign near Arcola is paying off with prolific production.

EASTERN INTERIOR

ILLINOIS

The Paint Creek sand is a new pay in the area of Wabash County 5 miles northwest of Mount Carmel in North Belmont pool. Alva C. Davis and Mike Bielaczyc 1 J. O. Smith, SW SW NW 5-1s-13w, recovered 1,140 ft. of gas and 210 ft. of clean oil on a drill-stem test at 2,527-52 ft.

WESTERN CANADA

ALBERTA

Basal Quartz Gas Discovery Reported

A four-company team carrying out a 10-well exploration program in the general Joarcam area of Alberta and headed by Canadian Export Gas, Ltd., was rewarded with a natural-gas discovery in the Basal Quartz formation at its second well in that program. The new discovery well, Canadian-Export Gas-Fargo-Dubar 2 Newclare, LSD 10-17-49-18w4, is 2 miles west of the town of Dodds, 28 miles southwest of Vegreville and 14 miles northeast of Viking sand oil producers in Joarcam oil field.

Canadian Export and the other companies in the team, Fargo Oils, Ltd., Dubar Exploration, Ltd., and Newclare Oils, Ltd., acquired, through a farmout agreement, exploration rights to a sizable portion of acreage from an undisclosed source.

Basal Quartz drill-stem test run around the 3,300-ft. level flowed gas at rate, 1,300,000 cu. ft. daily. Pipe recovery was 300 ft. of mud. Two other

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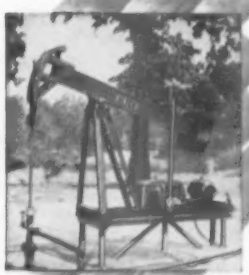

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zones, the Viking and Glauconitic sand, also gave up gas showings but both of those were deemed noncommercial.

Hole was completed at 3,780 ft. and production casing has been run, the well is currently standing, shut in.

More Work Planned In Chinook Ridge Area

Plans have been announced for more exploratory work in the wild Chinook Ridge area of northwestern Alberta. Stanolind Oil & Gas Co. has 75 per cent stake in a spread of about 700,000 acres in the area. They drilled the A-1 success on LSD 3, 12-65-13w6. The well made gas in the Viking, but has been shut in until winter. Stanolind will drill the A-1 Big Mountain well on LSD 4, 26-66-7w6; and the A-1 Pinto Creek on LSD 7, 26-67-10w6.

Big Mountain is 33 miles northeast of Chinook Ridge; Pinto Creek is 22 miles northeast. The operator will test to the Triassic at Big Mountain at about 9,660 ft. The Pinto Creek well will go to about 10,100 ft. for a look at the Triassic.

WEST TEXAS-NEW MEXICO

WEST TEXAS

Upton County Discovery Flows High-Gravity Oil

T. M. Evans, Dallas, ran final tests at 1-22 University in the Devonian through perforations at 10,332-72 ft., making 72 bbl. of oil with no water. The flow was through ¼-in. choke, under tubing pressure of 600 psi.

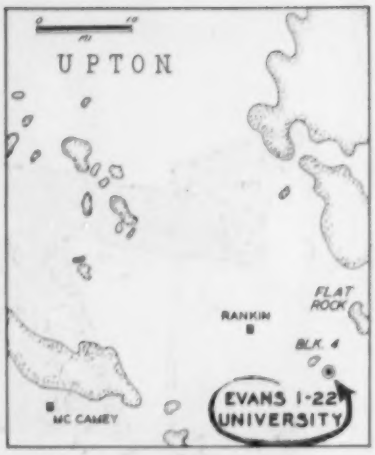
Gravity of the oil was 53° and gas-oil ratio was 9,093:1. On elevation of 2,814 ft., the well entered the Devonian at 10,170 ft., had pay at 10,330 ft., and had the Ellenburger at 11,260 ft. It also had flowing oil on a drill-stem test at 9,430-9,500 ft.

Flush Well Adds New Pay to Hockley Field

Honolulu Oil Corp. dually completed the second well in Smyer, North field, Hockley County, and gave the area its second pay zone.

The firm's 20-A Ellwood estate, flowed 1,015 bbl. of oil a day through ½-in. choke on tubing, from the new pay, Strawn limestone, at 9,967-88 ft. Flowing pressure was 325 psi. Gas-oil ratio was around 800:1.

Daily potential from Canyon lime was at the rate of 1,067 bbl., through



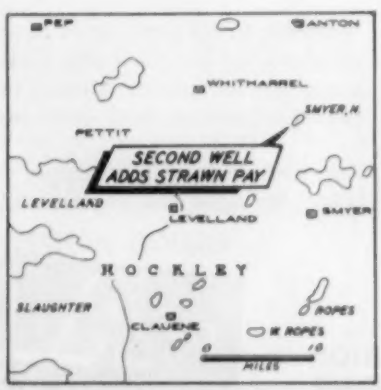
T. M. Evans 1-22 University opened Devonian production 12 miles east of Block 4, Wolfcamp pool.

⅜-in. choke, from perforations at 6,610-38 ft. Gas-oil ratio was 139:1.

Location of the well is in Section 32, Block A, R. M. Thompson Survey, ¾ mile southwest of Honolulu's field opener, 20-B Ellwood. This well flowed 1,309 bbl. of oil a day from Canyon pay at 9,630-72 ft. Smyer, North field is the northernmost field on the western side of the Horseshoe Atoll reef fields. (See *The Oil and Gas Journal, June 18, page 248* for a complete paper on the Horseshoe Atoll in West Texas.)

Concho County . . . The southwestern corner of Concho County had oil shows at a wildcat being drilled by Ray Smith Drilling Co. and Tucker Drilling Co.

The well is 1 Arthur Henderson, in 24-8-H&TC, 15 miles southwest of Eden. On test in a Pennsylvanian sand at 4,015-19 ft., the well recovered 690 ft. of gas, 30 ft. of oil and gas-cut mud and 20 ft. of oil. Bottom-hole flowing pressure was 125 psi. Projected



The second completion in Smyer, North field, Hockley County, was a long southwest offset, and added a second pay to the field.

depth was 4,900 ft. Location of the wildcat is a few miles north of an oil discovery by Tucker Drilling in northwestern Menard County.

MID-CONTINENT

OKLAHOMA

New Bartlesville Strike Reported in Alfalfa

A new gas-distillate discovery was reported for the Cherokee area of Alfalfa County, northern Oklahoma. Location of Calvert Drilling Co.'s 1 Newlin is near the Oakdale multipay field. The Newlin well, SW SE 19-25n-12w, is a workover discovery. From the sand at 5,838-48 ft. the discovery made 7,000 M.c.f. per day with distillate.

Calvert is also drilling another test at 1 Kassik, NW NW 19-25n-12w. This new discovery will increase interest in the Bartlesville sand potentialities of the Cherokee area. Amerada Petroleum Corp.'s recent Oakdale Simpson and Bartlesville pool discovery sparked the development.

HUGOTON EMBAYMENT

NORTHWEST OKLAHOMA

New Pay Opened at East Laverne Well

The Chester-Mississippian is a new pay sand for East Laverne field, Harper County. The discovery well is Sun Oil Co. 1 Carlisle-B, C SW NE 31-26n-24w, extending the field 1 mile south.

On drill-stem test at 7,084-7,142 ft. the well flowd 1,630 M.c.f. per day in 30 minutes. After 65 minutes it fell to 1,375 M.c.f. per day.

OKLAHOMA PANHANDLE

New Penn Pool Opened In Beaver County

The southeastern portion of Beaver County has a new Douglas-Pennsylvanian sand gas reservoir. The discovery well is White Eagle Oil Co. and Shell Oil Co. 1 Baldwin, C NE NE 30-1n-26eCM.

The discovery flowed 1,450 M.c.f. of gas in 90 minutes on a drill-stem test at 5,972-6,005 ft. Recovery was 270 ft. clean oil and 90 ft. heavily oil, gas and water-cut mud. A second drill-stem test made at 6,004-53 ft. flowed 60 M.c.f. of gas in 28 min-

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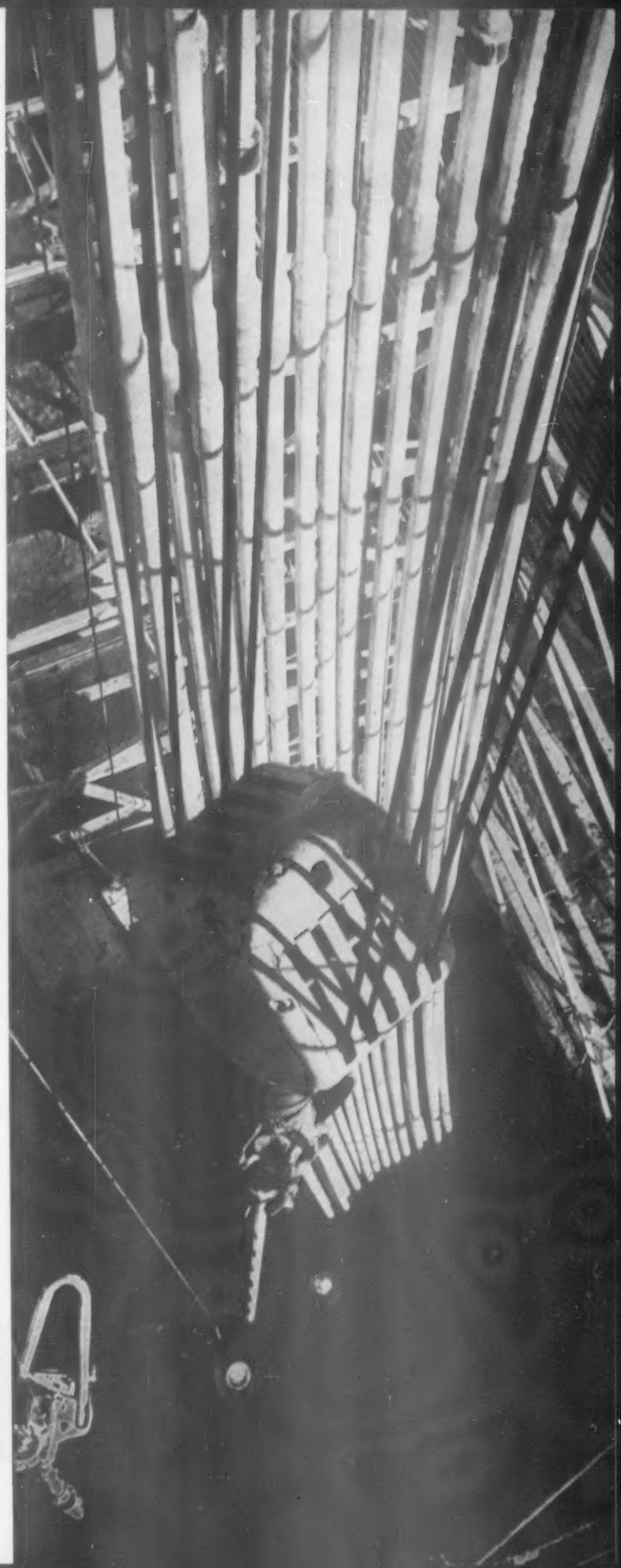

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utes, recovery being 360 ft. of 41°-gravity oil, 180 ft. very oily and gas-cut mud, and 180 ft. water-cut oil, and 90 ft. oily salt water. Drilling continues.

Completions Reported In Keyes District

Several good gas well completions are reported from the Keyes gas field in Cimarron County, far northwestern Oklahoma Panhandle. Colorado Interstate Gas Co. 1 Dittmar, SW SW NE 33-5n-8eCM, flowed 31,700 M.c.f. of gas per day from the Keyes-basal Pennsylvanian sand at 4,735-60 ft.; the 1 Philmag, NW NW SE 32-5n-8eCM, flowed 59,000 M.c.f. per day from 4,748-98 ft.; the 1 Wilmarth, NW NW SE 5-4n-8eCM, flowed 13,300 M.c.f. per day from Keyes sand perforations at 4,776-92 ft.

Morrow Success Noted At Mocane Area Well

Morrow gas production is proved at Kerr-McKee Oil Industries, Inc., 2 Raymond in C SE NE 31-6n-25eCM, Northwest Mocane field, Beaver County. The well flowed an estimated 12,000 M.c.f. per day on drill-stem test at 6,050-87 ft.

Southeast Boyd field . . . This Beaver County Morrow producer has another oil well at Union Oil Co. of California 1 Neufeld, SW SW NE 9-2n-21eCM. The well was completed for 374 bbl. of oil and 2,310 M.c.f. of gas per day on 20/64-in. choke from perforations at 7,113-54 ft.

TEXAS PANHANDLE

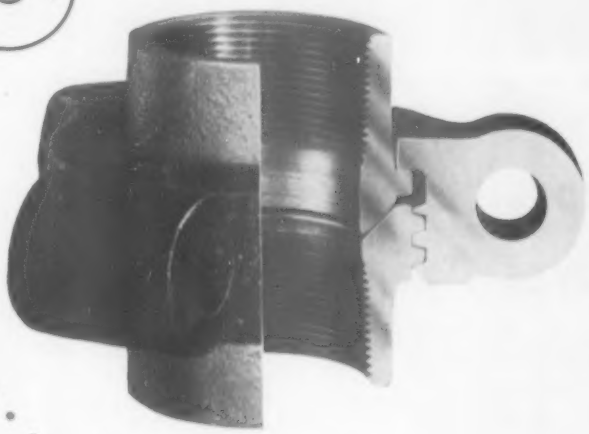
Morrow Sand Pool Opened in Ochiltree

Woodson Oil Co. opened a new Morrow sand gas-producing area in north-central Ochiltree County 4 miles southeast of Perryton townsite. The 1-G Perry Unit was completed flowing 2,600 M.c.f. of gas per day on ¾-in. choke from perforations at 7,792-7,802 ft.

Location is in Section 1014, Block 43, H&TC Survey.

Hansford discovery . . . Shamrock Oil & Gas Co. completed 1 Schiff, northeastern Hansford County, as a Tonkawa-Pennsylvanian gas discovery, 7 miles northeast of Gruver townsite in Section 77, Block 45, H&TC Survey. The well flowed 2,050 M.c.f. of gas per day from perforations at 5,343-69 ft.

THE 3 MOST IMPORTANT FUNCTIONS OF A UNION



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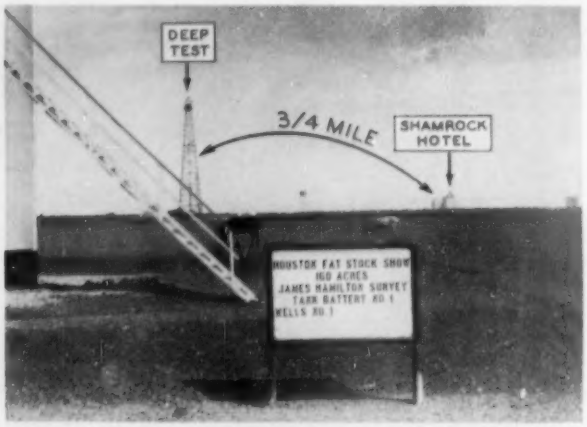
New flank sand development makes old Pierce Junction salt dome busiest spot on Gulf Coast. Shown is some of drilling activity on northeast side of dome.

Houston's Pierce Junction Lives Again

By

Neil Williams



Drilling at Pierce Junction nears Houston's luxurious Shamrock-Hilton Hotel. Shown is Magnolia-Stanolind deep test on field's north side at city's southwestern outskirts.

DRILLING activity around the old Pierce Junction salt dome at the southwest outskirts of Houston continues at record level. Twenty-nine operations were under way last week with locations made for nearly a dozen additional wells. This remains the largest concentration of field development anywhere along the entire coastal region of Texas and Louisiana.

No immediate appreciable let-up in work is foreseen unless forced by shortage of tubular goods and other materials that might arise if the current strike in the steel industry is prolonged. Despite the intensive and large-scale development which has already taken place, steadily spreading productive limits and extension of exploration to other sectors of the dome and horizons than those so far exploited open the way for further widespread drilling.

The present play, which had its inception late in 1954 with the discovery of oil production in Vicksburg sands off the east flank of the dome, has resulted in the completion of upwards of 150 wells, including 15 dry holes. Except for 8 wells, all have been drilled within the past year, 110 of them being drilled this year. Peak month was April with 22 completions.

Development, stepped up late in 1955 following extension of the new Vicksburg production from the east to the north side of the dome, until now has been focussed primarily on proving up the intervening sector of the dome's periphery. There, intensive and relatively close drilling has been occasioned by numerous small land and lease ownerships and complex reservoir conditions characteristic of most shallow, piercement-type domes.

New production . . . As a result of this activity, new production now stretches in an almost unbroken band from the original eastside discovery area around the northeast and north sides to the northwest flank. Already, exploration is moving farther around the northwest side to the west flank, and on the opposite extremity of the productive bank. New activity is springing up to extend the play farther eastward and outward from the dome. Also, on the far southwest side, Gulf Oil Corp. is drilling at a location a mile out from Vicksburg. This production was developed in a prior drilling play, started in 1947, which extended around the south side of the dome.

Vicksburg production in the current play off the east and north flanks of the dome is being found at depths ranging from about 6,900-8,100 ft. While this is the primary objective, other horizons also are proving productive in some wells, principally in shallower sands encountered in wells located higher up and closer in to the dome.

More than 35 companies, or groups of companies, or independents, currently are involved actively in the play, either with productive acreage already drilled, or now drilling. The majority, principally in the activity on the east and northeast sides, are independents, Most active of these has been Scurlock Oil Co., which drilled the discovery well on the east flank, setting off the play.

Included among the larger companies, however, are Gulf Oil Corp., Humble Oil & Refining Co., The Texas Co., and Magnolia Petroleum Co., all of whom have substantial acreage holdings on and around the dome.

Magnolia Petroleum Co. and Stanolind Oil & Gas Co. have figured prominently with their joint development of land owned by the Shamrock-Hilton Hotel interests. The land, located on the north flank of the dome, is close to Houston's city limits, less than a mile

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The new development at Pierce Junction is only one of a succession plays which have taken place in proving up the multiple reservoirs and productive horizons on and around the dome. It bears out the long-established conception that no matter how extensively and intensively a shallow piercement-type coastal dome may have been drilled, there always remain additional sectors, sands, and reservoirs to be explored.

Pierce Junction is one of the older known domes on the Texas coast, and has been dril'ed around, off and on, since early in the century. The first commercial oil well was completed in February 1921. It currently is productive from at least eight different horizons, ranging from the Miocene through the Yegua with depths from 3,000 ft. to below 9,600 ft.

ROCKY MOUNTAIN

NORTHWEST NEW MEXICO

Bisti Report

Sunray Mid-Continent Oil Co. has completed its seventh oil well in the new Bisti field in San Juan County, New Mexico. The well, the 7 Federal "C," flowed oil at the rate of 374 bbl. of oil a day following perforations at 4,829-91 ft. in the lower Gallup sand. The well was fractured with oil and sand.

The well is located in 31-26n-12w, south of Farmington.

Sunray Mid-Continent's other wells on its Federal "C" lease include the 1 "C" which flowed 288 bbl. of oil a day; the 2 "C" which flowed 192 bbl.; the 3 "C" which flowed 670 bbl.; the 4 "C" which flowed 480 bbl.; the 5 "C" which flowed 666 bbl.; and the 6 "C" which flowed 450 bbl.

In addition, Sunray Mid-Continent is now in the process of completing the 9 "C" and is drilling the 12 "C" and the 13 "C" and "14" C.

Sunray Mid-Continent holds 2,500 acres in the "C" lease and another 2,500 acres in the adjoining Federal "B" lease

ARK-LA-TEX

NORTH LOUISIANA

June Exploration

Exploratory work in North Louisiana during June netted one new oil field discovery, two new pays in older fields, and a field extension strike.

Durbin Bond & Co., Inc., 1 Davis-Ford, 11-8n-6e, opened Tew Lake field, 4 miles north of Jonesville and 3½ miles northwest of West Pool Lake field in Catahoula Parish, east-central Louisiana. The well flowed 54 bbl. of oil per day plus 60 per cent salt water on ¼-in. choke from Wilcox sand perforations at 4,367½-68 ft. The east offset try was dry.

Homer field . . . Pettet production at Homer in Claiborne Parish was established by Maritgky & Bibby and Associates at 8 W. M. McClung estate, C SE SW 29-21n-7w. The well flowed at the rate of 53 bbl. per day on ⅛-in. choke from perforations at 3,363-73 ft. Homer field produces from the Nacatoch, Ozan, Tokio, and Cotton Valley.

Red Rock . . . Hunt Oil Co. and Associates opened first Tokio sand production in Red Rock field, Webster Parish, at 2 J. B. Elkins et al in 8-23n-9w. The well flowed 189 bbl. of oil per day on 12/64-in. choke from perforations at 3,084-94 ft.

Grogan extended . . . Grogan field in Natchitoches Parish was extended 1¼ miles northwest at E. C. Wentworth's 1 Franklin Realty Co., C SE SE SW 20-11n-10w. The well flowed 5 bbl. of oil per day plus 4/10 per cent basic sediment and water on 16/64-in. choke. Perforations at 1,133-43 ft. in the Nacatoch was the discovery pay zone.

ARKANSAS

June Exploration

Three new oil fields and one new gas field were opened in Arkansas during June.

North Troy field was opened in Nevada County, southwestern Arkansas, by W&W Drilling Co. The discovery well, 1 J. B. Warmack, NE¼ 3-14s-20w, is a Tokio sand producer at 2,451-59 ft.

East Troy field was opened in southwestern Ouachita County by Warren & Hollyfield. The discovery well was 1 E. H. Clippert, C NE SE SW 16-14s-19w, 1½ miles west of Buena Vista field. It pumped 90 bbl. of oil per day from the Nacatoch sand through perforations at 1,313-18 ft.

Olin Forest field was opened 3 miles southwest of Hillsboro in Union County by Smackover Producing Co. as a good Tuscaloosa sand discovery. The A-2 Olin, south and east of C SW NE SW 27-18s-14w, flowed 208 bbl. of oil per day on ½-in. choke from perforations at 3,236-40 ft.

Snow Hill Drilling Co., Inc., and Associates opened a Cotton Valley area at Morphlet on the south side of old Smackover field in Union County. The 1 McMillan Petroleum Corp., SE SW 21-16s-15w, pumped 120 bbl. of oil per day from perforations at 4,336-40 ft. Nearest Cotton Valley oil is found in Snow Hill field on the north side of Smackover field, 5 miles to the north in Ouachita County.

Arkansas' new gas field was opened by Reynolds Mining Corp. in Sebastian County 2¼ miles east of Gragg field. The 1 Turner, 27-6n-30w, 4½ miles southeast of Greenwood, was completed on open flow for 5,200 M.c.f. and 3,000 M.c.f. per day from two zones in the Atoka-Penn at 2,553-69 ft. and 2,774-92 ft.

PACIFIC COAST

CALIFORNIA

Texaco Recompletes Bridge Pool Discovery

The Texas Co. has recompleted its Bridge Pool-South Mountain field discovery well in Ventura County. Texaco went back into the well and perforated the zone between 7,717-8,188 ft. for an initial flowing production rate of 606 bbl. daily of 33.6°-gravity crude through a 22/64-in. choke.

The well was orginally completed last December for only 38 bbl. daily of 31.7°-gravity crude from 7,211-7,720 ft. After a sandfrac job in late January, production was boosted to 121 bbl. daily. The decision to go back into the well and perforate the deeper zone followed completion of the first two offsets which flowed at rates far in excess of the discovery. The east offset flowed 925 bbl. daily and the north offset 821 bbl. daily. Both were producing from a interval deeper than the discovery's original completion depth.

Shell Scores at Vallecitos

Shell Oil Co. has given the Vallecitos area of San Benito County another new field discovery with completion of 58-31 F & I located more than 1½ miles northwest of Long and Hedges' Southeast Vallecitos field discovery made last year. Shell's wildcat was brought in flowing 460 bbl. of 34.9°-gravity crude through a 24/64-in. choke. The well was selectively perforated in four intervals between 3,300 ft. and 3,440 ft.

Getty Hits at Piru

Getty Oil Co. put 33 Temescal, located 2½ miles northeast of Piru in Ventura County, on pump for a new pool discovery midway between the Ramona field and the Modelo area.

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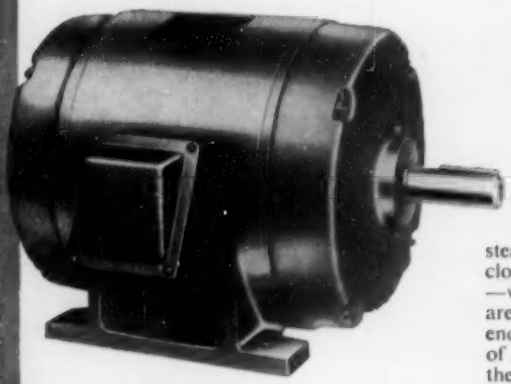

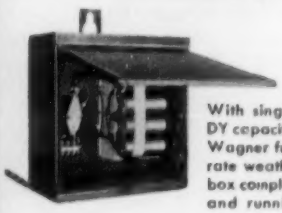

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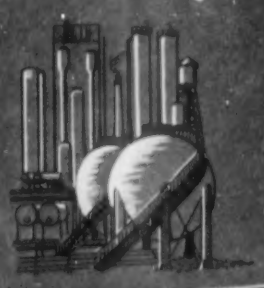
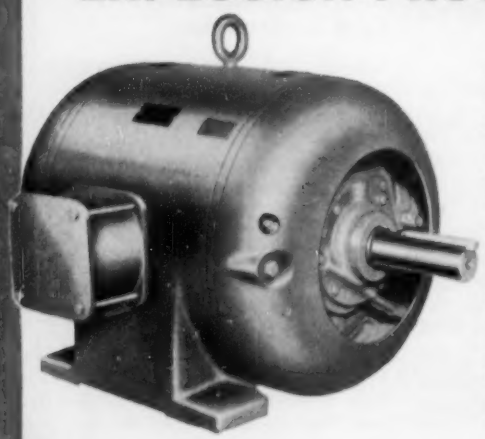


EXPLOSION-PROOF MOTORS



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Initial production on the wildcat was 200 bbl. daily of 15.2°-gravity crude from the interval 1,950-2,060 ft.

Mariposa Makes New Pool Find at Mountain View

Mariposa Co. chalked up a new pool discovery 1 mile south of the town of Arvin in southern Kern County. Mariposa completed the 8,250-ft. 73-35 Kovacevich in the interval 7,967-8,020 ft. flowing 135 bbl. daily of 36.1°-gravity crude through a 10/64-in. choke. This discovery is approximately 1 mile northwest of The Texas Co.'s Vaccaro pool discovery scored last September. It is in SE NE 35-31s-29e.

Sunset Stakes Humboldt County Gas Test

Sunset Oil Co., acting as operator for itself and Signal Oil & Gas Co., will drill a 7,000-ft. test 3½ miles southwest of Tompkins Hills gas field in Humboldt County, northern California. The wildcat, 1 Sunset-Signal, will search for Pico formation gas production, source of The Texas Co.'s prolific discovery in the Tompkins Hills field. The Sunset-Signal combine holds 5,000 acres in the county south of the town of Eureka. Signal did the seismic work on the lease. Santa Fe Drilling Co. has the drilling contract.

Humble Gets Oil Producer At Semitropic Gas Field

Humble Oil & Refining Co. made a new oil discovery on the southeast flank of the Semitropic gas field in Kern County. Humble 1 E. G. Williams tested 66 bbl. daily of 30°-gravity crude, 2 per cent cut, through a ½-in. choke from 7,737-7,485 ft. Total depth of the wildcat is 7,700 ft. Nearest oil production is more than 2 miles northeast in Wasco field. Production at Wasco includes Standard Oil Co. of California's 15,535-ft. 5 Mushrush, the state's deepest producer.

GREAT LAKES

MICHIGAN

The Reynolds Dundee - Reed City zone oil pool, Montcalm County, was extended further to the southeast (1 40-acre location more) by the Robert Bond & Russell Otterbine 1 Lovegran, SE NE NW 18-12n-9w, Winfield Township. This most southeasterly well to reach pay in this area filled and flowed oil natural within 40 minutes after pay was tapped at 3,338-39 ft. Well flowed as much as 20 bbl. first half hour on test,and on later flows produced at the rate of 20 bbl. an hour. This appeared to be the strongest and best well drilled to date by Bond and associates on the south-southeast side of the pool. Production was being restricted to 75 bbl. of oil daily, proratable allowable for Reynolds well. Dundee top was logged at 3,235 ft. Hole was bottomed out at 3,339 ft. The interval between top of Dundee and pay showed a thickening of about 10 ft. over the well in the pool with the thinnest interval. However, this was not the thickest interval recorded at producing wells in the pool. The interval at the 1 Lovegran was 104 ft. Whether this thickening will prove to be indicative of what is happening on this flank of the pool will not be definitely determined until other offsets are drilled. It may not have too much bearing on the productive liklihood for other, south and southeast acreage.

Successful Wildcats

ALBERTA

Imperial Canadian Superior 16-18 Tomahawk, LSD 18-52-5w5. TD 9,177 ft. Basal quartz oil well.

Can. Export-Fargo-Dubar 2 Newclare, LSD 10, 17-49-18w4. TD 3,780 ft. Basal quartz gas well.

ARKANSAS

Union County: Snow Hill Drilling Co. et al 1 McMillan Petroleum Corp., SE SW 21-16s-15w. IPP 120 BOPD, Cotton Valley 4,336-40 ft., 31.6°. TD 4,517 ft. (Discovery of Smackover-Norphlet field).

CALIFORNIA

Kern County: Mariposa Co. 73-35 Kovacevich, SE NE 35-31s-29e, 135 BOPD, 36.1° gravity, 0.5 per cent cut, 10/64-in. choke, perfs. 7,967-8,020 ft., TD 8,250 ft. (New pay discovery about 1 mile south of Arvin in southern Kern County.)

COLORADO

Jackson County: Cabeen Exploration Co. 1 "A" Blevins, SW NE NW 11-9n-78w. IP 6,000 M.c.f. of gas per day, Muddy sand. TD 1,593 ft. (New gas field in North Park basin).

Morgan County: Argo Oil Co. et al 1 Segelke, E½ NW SE 22-5n-55w. IPP 55 BOPD, "J" sand discovery, new field. TD 5,114 ft. "J" sand.

INDIANA

Posey County: George S. Engle 1 Schmidt, NE SW SE 31-4s-13w. IPP 50 BOPD, Cypress sand 1,933-38 ft., 27°, T)D 1,940 ft. (Discovery of South Rodgers pool).

SOUTH LOUISIANA

Cameron Parish: CATC Group 1-D OCS 0187 (State Lease 1632), Block 83, East Cameron area, Gulf of Mexico. IP 33.1 BCPD and 3,700 M.c.f. daily, ¾-in., 60°, perforations 8,536-50 ft., and (dual completion) 73.3 BCPD and 4,200 M.c.f. daily, ¼-in., 58.9°, perforations 9,950-58 ft., and 9,978-84 ft. TD 10,127 ft. (New offshore field).

Lafourche Parish: California Co. 3 Alton Jones et al 2, 18-17s-21e. IP 130 BCPD and 8,086 M.c.f. daily, ⅛-in., 47.5°, perforations 11,846-70 ft. TD 13,200 ft. (Extends LaRose field).

Olin Gas Transmission Corp. 5 Grandison, 9-19s-23e. Flowed gas and condensate (no gage), ¼-in., shut-in, perforations 9,904-07 ft. TD 12,769 ft. (New pay and first gas-condensate production in Coffee Bay field).

Plaquemines Parish: California Co. 1 State Lease 1262 (OCS 0373), Block 40, Main Pass area, Breton Sound. IP 3,331 M.c.f. daily, 3/16-in., dry gas, perforations 3,478-88 ft. TD 10,000 ft. (New Offshore field).

Plaquemines Parish: Richardson & Bass 2 Humble-Continental State Lease 2513, Township 17s-14e (northwest of Pointe-a-la-Hache). IP 140 BOPD and 161 M.c.f. daily, ⅛-in., 35.1°, perforations 10,758-65 ft. TD 11,505 ft. (New field).

MONTANA

Yellowstone County, Wolf Springs field: Atlantic Refining Co. 13-2 Horton estate, C SE NE 13-7n-31e. IPF 256 BOPD, Piper lime; 417 BOPD, Amsden dolomite. TD 6,085 ft. (Piper discovery at Wolf Springs).

NEBRASKA

Banner County: New Drilling Co.-Sunray Mid-Continent 1 Ludden, C SW SW 13-17n-57w. IPP 151 BOPD, "J" sand discovery, new field. TD 6,918 ft.

Kimball County: T.C.T. Corp. et al 1 Beard, SE SE NE 14-14n-55w. IPP 100 BOPD, "J" sand. TD 6,355 ft. "J" sand discovery, new field.

SOUTHEASTERN NEW MEXICO

Eddy County: William Hudson 1 Torres, 9-18s-26e. IP 50 BOPD, ¼-in., TP 75 psi., 40°, GOR zero, pay 1,691 ft. TD 1,727 ft.

Lea County: Sunray Mid-Continent Oil Co. 1-K State, 11-10s-32e. IP 120 BOPD, choke (?), TP 2,258 psi., 50°, Pennsylvanian perforations 10,180-91 ft. TD 10,-775 ft., elev. 4,274 ft., top Devonian 10,-758 ft.

Lea County: U. S. Smelting, Refining & Mining Co. 1 Superior-State, 34-13s-32e. IP 429 BOPD, 20/64-in., TP 1875 psi., GOR 1760, 48°, Devonian perforations 12,338-44 ft. TD 12,359 ft., elev. 4,318 ft., top Devonian 12,310 ft.

SASKATCHEWAN

Imperial 15-22 Florence, LSD 15, 22-2-34w1. TD 4,954 ft. Charles oil well.

Imperial 7-21 Kingsford, LSD 7, 21-4-6w2. TD 5,270 ft. Mission Canyon oil well.

Imperial 7-19 Gainsborough, LSD 7, 19-2-30w1. TD 3,810 ft. Mission Canyon oil well.

WYOMING

Natrona County: M. F. Lewis 1 Government, SE SW NE 27-40n-80w. IPP 100 BOPD, Niobrara discovery, new field. TD 1,200 ft.

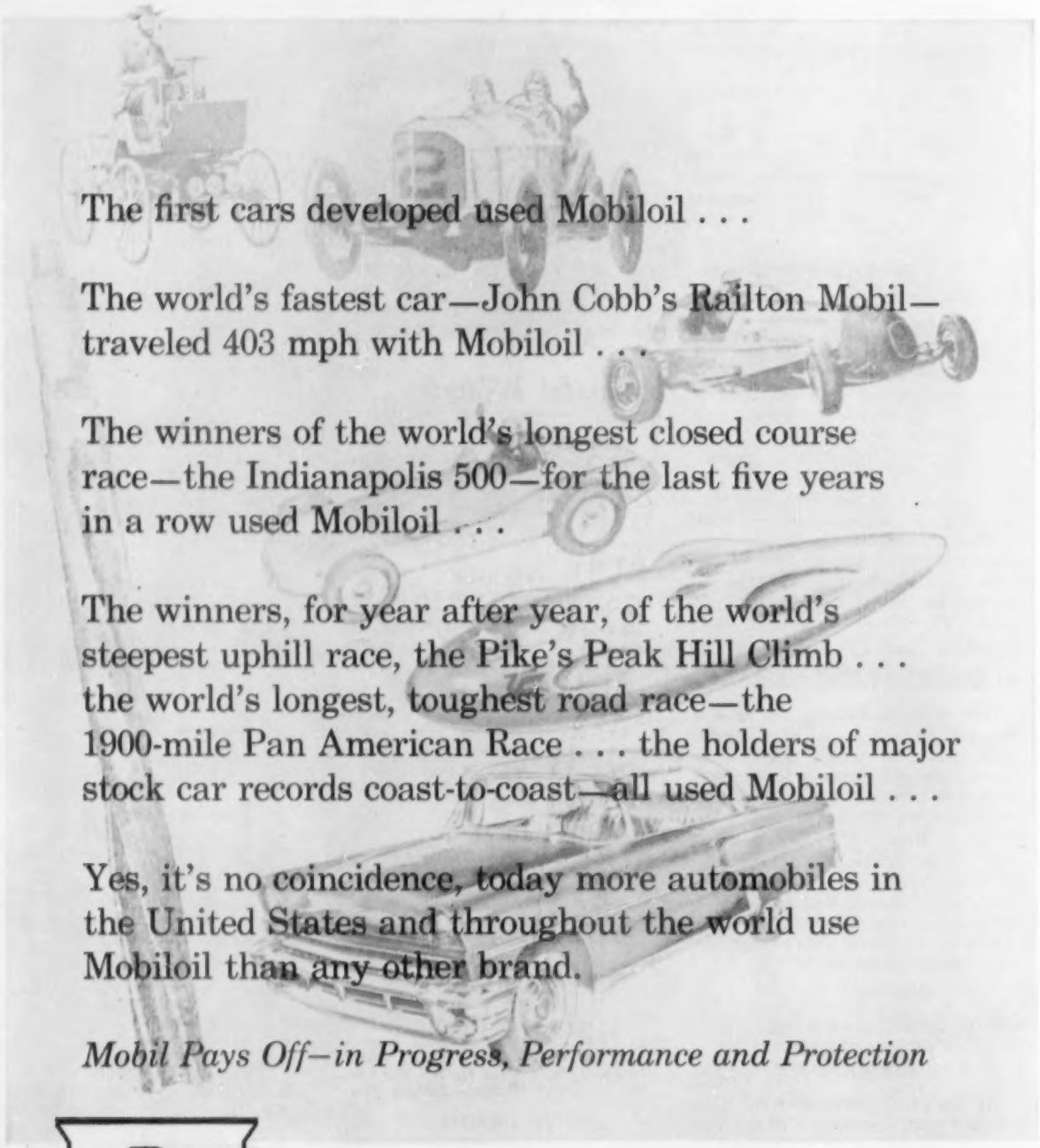
TEXAS GULF COAST

Colorado County: W. U. Paul 1 Miller et al, Ben R. Thomas ⅓ League, A-549. Shut-in oil well, no gage, perforations 9,688-96 ft. TD 10,214 ft. (New field).

Cities Service Oil Co. 17-6 Columbus Field Unit, J. Tujlinson Sur., A-46. IP 163 BOPD, ¾-in., 36.9°, perforations 8,760-70 ft., and 5,000 M.c.f. daily, open-flow potential, GCR 20.9 M.c.f. per bbl., perforations 8,474-76 ft. TD 10,220 ft. (New pay—perforations 8,760-70 ft.—Columbus field).

Jackson County: H. H. Howell et al 1 W. P. Jackson est., S.C.A. Rogers Sur., A-65.

It's no Coincidence...



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WEST TEXAS

Andrews County: W. R. Weaver 1 Thornberry, 8-A42-PSL, 9 mi. W. Andrews. IP 140 BOP, 25/64-in., TP 120 psi., 32°, pay 4,550 ft. TD 4,745 ft.

Crane County: Gulf Oil Corp. 1-D Edwards estate, 16-43-T4S-T&P, 17 mi. NW Crane. IP 465 BOPD, ½-in., TP 195 psi., GOR 818, 47°, Ellenberger perforations 11,-785-825 ft. TD 12,070 ft., ground elev. 2,760 ft. Pay carried on some reports as Connell.

Gaines County: J. C. Williams 2 Riley estate, 259-G-WTRR Sur., 6 mi. SW Seminole. OWDD, originally completed dry at 11,-694 ft. IP 363 BOPD, 18/64-in., TP 425 psi., GOR 670, 42.8°, Strawn perforations 10,406-60 ft. New TD 13,314 ft.

Howard County: A. K. Turner Jr. 1 J. S. Walker, 27-33-T2N-T&P, 13 mi. NW Big Spring. OWWO, originally drilled to 8,900 ft. PB 7,196 ft., Spraberry pay 6,665-75 ft. IP 168 BOPD, ¼-in., CP 290 psi., GOR 800, 40°.

Scurry County: Trice Production Co. 1 Adams, 156-97-H&TC, 9 mi. SW Snyder. IP 168 BOPD, 12/64-in., TP 350 psi. GOR 995, 44°, Canyon reef 6,872-87 ft. TD 6,890 ft.

Winkler County: Stanolind Oil & Gas Co. 23 Sealy & Smith "A," 51-A-G&MM-B&A Sur., new pay discovery in Monahans North field. Dual well, previously completed in the Ellenburger. IP 300 BOPD, 24/64-in., TP 250 psi., GOR 931, 37°, Montoya perforations 10,092-114 ft. TD 12, 795 ft.

Gaines County: David Fasken 1 Jones, 31-AX-PSL, 10 mi. SW Denver City. IP 514 BOPD, ¼-in., TP 290 psi., GOR 209, 40°, Devonian 11,152-72 ft. TD 11,187 ft., elev. 3,608 ft.

Irion County: Russell McGuire 1-B Sugg, Sec. 48, C. A. Chadwick Sur., A-1090, 2 mi. NW Mertzon. IP 103 BOPD, 20/64-in., TP 275 psi., GOR 1996, 36°, pay 6,472-86, 6,497-6,514 ft. TD 7,875 ft.

Midland County: M. H. Baxter 1 Heidelberg, 29-38-T2S-T&P, 9 mi. SE Midland. IP calculated open flow 11,100 M.c.f. gas. Strawn pay top 10,320 ft. TD 12,324 ft. Condensate yield, 1,460 bbl. per day, GLR 7,600:1.

Upton County: Russ Williams Drilling Co. 1 Damron, 192-F-CCSD&RGNG Sur., 9 mi. SE Crane. IPP 117 BOPD, 32°, GOR zero, Grayburg 3,241 ft. TD 3,491 ft.

NORTH TEXAS

Jack County: Grace-Schlittler Operating Co. 3 Pemberton, D. Lehman Sur., A-351, 6½ mi. S Bryson. IP 48 BOPD, 18/64-in., 41°, GOR 675, TP 90 psi., pay 1,944 ft. TD 1,947 ft.

Wise County: Christie, Mitchell & Mitchell 1 Hutchinson, T. Leftwick Sur., A-500, 1½ mi. S Chico, recompleted as oil and gas discovery from Upper and Lower Atoka conglomerate zones. IP 189 BO PD, 17/64-in., 42°, TP 235 psi., GOR 628, perforations 5,532-38 ft.; IP 970 M.c.f., SIP 541 psi., perforated 5,536-40 ft. TD 5,810 ft. Old TD 4,560 ft.

Southern Union Gas Co. 1 McKissick, Samuel Isaacs Sur., A-454, 3½ miles S Decatur. Originally completed dry at 6,000 ft., TD. IP 30,500 M.c.f., plus 30 bbl. condensate per day, 18/64-in., SIP 1,235 psi., perforated 5,918-40 ft., new TD 6,072 ft.

Young County: Fess E. Parker 1 Robinson, Blk. 1649, TE&L Sur., A-936, 12 mi. SW Proffitt. IP 720 BOPD, ½-in., TP 200 psi., 40°, GOR 650, Upper Caddo 3,806-14 ft., TD.

Philwell Oil Co. 1 Glidewell, Wm. Childress Sur., A-1392, 14 mi. SE Graham. IPP 53.36 BOPD, 38°, GOR 300, Strawn 1,614-24 ft. TD 1,716 ft.

Grayson County: Arnold H. Bruner 1 Wright, J. B. Gorrell Sur., A-472, 4½ mi. E Sadler. IPP 106.6 BOPD, 30°, GOR 500, Baker sand 7,946-58, 8,004-22 ft. TD 8,667 ft.

Wise County: K & H Operating Co., Inc., Christie, Mitchell & Mitchell 1 Gasperson, S. Wood Sur., A-896, 2 mi. N Bridgeport. IP 224 BOPD, 16/64-in., TP 780 psi., 43°, conglomerate 5,496-5,502, 5,536-40 ft. TD 6,045 ft.

WEST CENTRAL TEXAS

Eastland County: Derrick and Hopkins 1 Shults, Subd. 4, John F. Sapp Sur., 5½ mi. N Rising Star. Old total depth 1,705 ft. IP 31.47 BOPD, 26/64-in., TP 25 psi., 41.8°, GOR 997, Marble Falls 2,942 ft. New TD 2,985 ft.

Jones County: The Texas Co. 3 Jennings estate, Sec. 1, I&GN Sur., 2½ mi. NW Lueders. Old well redrilled, Old TD 2,067 ft., PB 1,680 ft. IPP 339 BOPD, 34°, GOR 140, Tannehill sand 1,630-36 ft.

Taylor County: J. C. Axelson 1 Sharp, M. P. King Sur. 466, 4 mi. SE Lawn. IP 124 BOPD, 14/64-in., TP 220 psi., 39°, GOR

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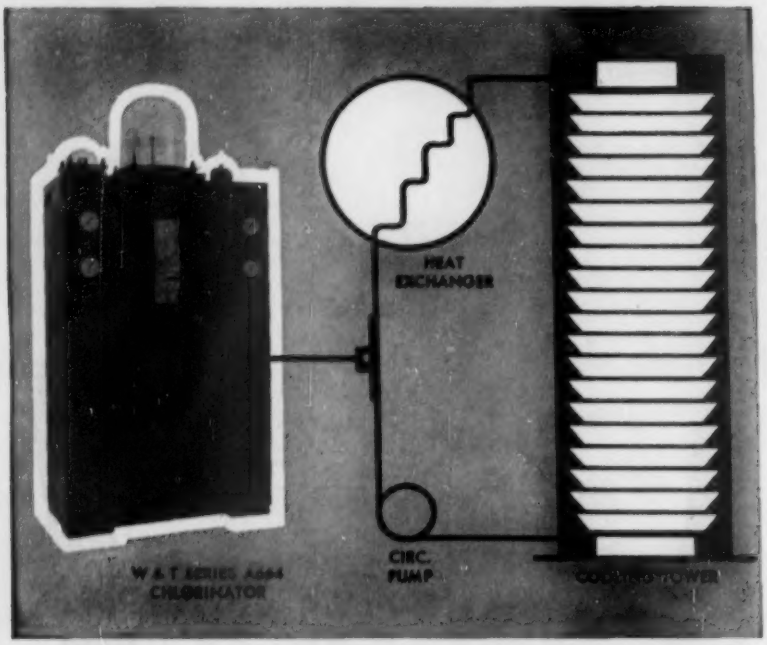

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950, Gardner sand 3,866-70 ft. TD 4,023 ft.

Nolan County: A. G. Hill 1 Harp, 12-X-T&P, 8 mi. S Sweetwater. IPP 31 BOPD, 35°, GOR 515, Canyon sand pay 5,448 ft. TD 7,010 ft.

Stephens County: J. E. Connally 1 Norvell, John Stevenson Sur. 29, A-159, 14 mi. SW Breckenridge. IP 108.5 BOPD, 18/64-in., TP 750 psi., 41.8°, GOR 850, conglomerate perforations 3,768-70 ft. TD 4,130 ft.

Leo Vessemer Jr. 1 Baker, W. T. Malone Sur., A-114, 14 mi. NW Breckenridge. IP 114.47 BOPD, 16/64-in., TP 350 psi., 40°, GOR 250, Mississippian lime 4,471-77 ft. TD 4,567 ft. Suggested field name, Snake Den-Mississippian.

Throckmorton County: Carlton D. Speed Jr. 1 Keeter, Sec. 2114, TE&L Sur., 3 mi. SE Elbert. IPP 137 BOPD, 41.5°, GOR 650. TD 4,764 ft.

Eastland County: K L B Oil Corp. 1 Dunning, 92-3-H&TC, 6 mi. SW Cisco. IP calculated 486 BOPD, 42°, 26/64-in., TP 220 psi., GOR 450, pay 2,830-70 ft. TD 3,818 ft.

Shackelford County: Magnolia Petroleum Co. 25 Matthews, Sec. 29, ETRR Sur., 2 mi. N Albany. IP 181 BOPD, 18/64-in., TP 750 psi., GOR 176, 43°, Mississippian 4,704-77 ft. TD 4,962 ft.

Sheets & Walton Drilling Co. 1 Hudman, Sec. 16, BOH Sur., 5 mi. NE Moran, previously completed as shut in gas well. IP 41.6 BOPD, 16/64-in., TP 500 psi., GOR 1950, 40°, pay 4,010-15 ft. TD 4,268 ft.

Stonewall County: T. F. Hunter 1 Wylie, 167-D-H&TC, 3 mi. Aspermont. IP 106 BOPD, 32/64-in., TP 110 psi., 41°, GOR 300, Strawn sand 5,603-13 ft. TD 6,631 ft.

Throckmorton County: Barney Feagin 1 Richards, J. B. Campbell Sur., A-1406, 5½ mi. SW Throckmorton. IP 180 BOPD, 12/64-in., TP 600 psi., 42°, GOR 765, Caddo 4,586-94 ft. TD 4,876 ft.

EAST TEXAS

Cass County: W. N. Dorsett 1 Elbert Rambo, Jesse Dinson Sur., A-305, 3 mi. S McLeod. IP 117 BOPD, 24/64-in., TP 250 psi., 42°, GOR 5200, Hill sand 5,654-76 ft. TD 7,005 ft., elev. 283 ft. Suggested field name, Rambo-Hill.

TEXAS PANHANDLE

Ochiltree County: The Texas Co. 1 Barlow-Cooper-Rich Unit, 5 miles southeast of Perryton, 1 mile north of Morrow gas production in Sec. 1008, Blk. 43, H& TC Sur. IP 537 M.c.f. of gas per day and 16 BDPD, perforations 8,078-8,463 ft. TD 8,580 ft. (Gas-distillate discovery in Hugoton embayment).

Trice Production Co. 1 Wood Bros., 2 miles north of Perryton in Sec. 5, Blk. 11, W. Ahrenbeck Bros. Sur. IP 3,249 M.c.f. of gas per day, Morrow 7,706-8,017 ft. TD 8,166 ft. (Gas discovery in Hugoton embayment).

Roberts County: Humble Oil & Refining Co. 1 Flowers Bros., 8 miles north of Quinduno field in Sec. 74, Blk. C, G&M Sur., 13½ miles northwest of Miami. IP 5,200 M.c.f. of gas per day, Brown dolomite-Permian 3,864-3,882 ft. TD 3,971 ft. (New gas discovery in deep portion of northwestern Anadarko basin).

Humble 2 Flowers Bros., 12.5 miles northwest of Miami in southeast part of county, 8 miles north of Quinduno field in Sec. 73, Blk. C, G&M Sur. IP 10,356 M.c.f. of gas per day, Brown dolomite 3,888-3,914 ft. TD 3,980 ft. (New gas discovery).

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Anything that helps to make driving safer gets special attention at National Supply. That's because we drive a lot to serve you. Our field men drive 700 vehicles more than 1,600,000 miles every month, or about 1 1/10 times around the world for each car, each year.

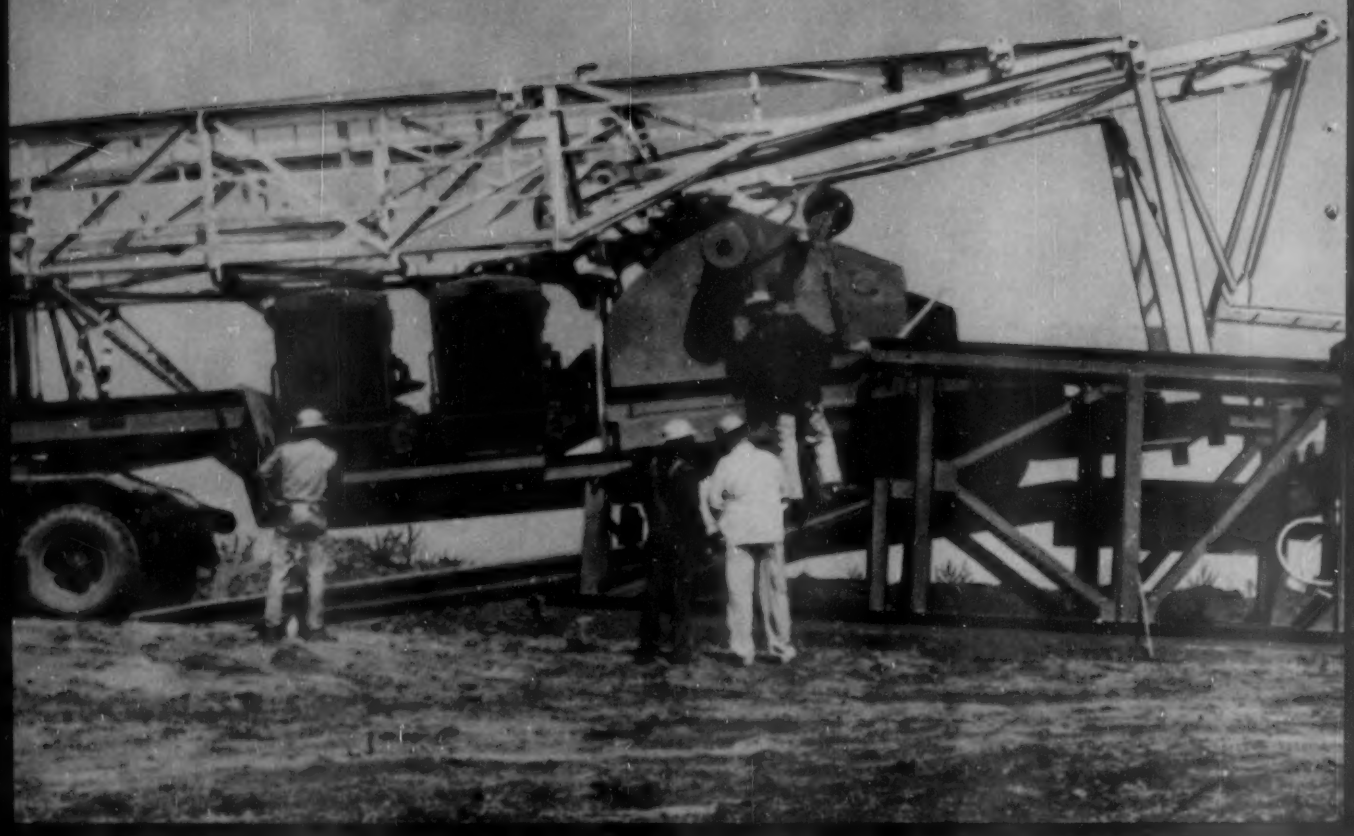
Early this year, as an extra precaution, we had safety belts installed in every National car. We've found them so worthy that we've added safety belts on the stock lists in some of our stores.

Is the safety belt an unusual item for oil field stores to stock? We don't think so. We believe in store inventories, tailored to area needs, that offer operators whatever they want in field equipment and supplies. As a result, some National stores stock snake bite kits. Some sell geiger counters, many sell detergents. Others have considerable marine equipment to serve offshore rigs. If you need a special item not in stock, we work fast to get it for you. And we always like to recommend products—like the safety belts—we use ourselves.

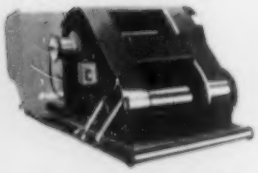
Your satisfaction with such National Supply store policies has made us the world's largest oil country supplier. While we're constantly looking for additional ways to improve our service, we trust you'll always tell us whenever and wherever we can serve you better.

THE
NATIONAL SUPPLY
COMPANY

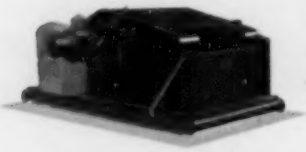
OPERATORS REPORT "MINIMUM



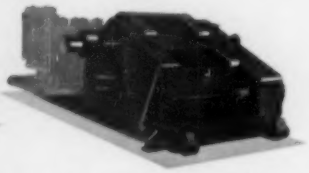
THERE'S A NATIONAL TRUCK-OR TRAILER-MOUNTED RIG
TO SERVE EVERY OPERATOR'S NEED!



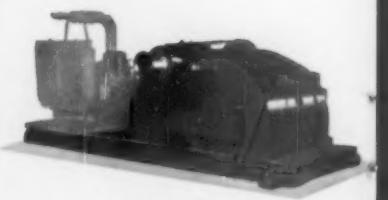
NATIONAL T-8 AND T-8-S RIGS
RATED AT 80 H.P.



NATIONAL T-12 AND T-12-S RIGS
RATED AT 120 H.P.



NATIONAL T-20 AND T-20-S RIGS
RATED AT 200 H.P.



NATIONAL T-32 RIGS
RATED AT 320 H.P.

DOWNTIME . . . FASTER OPERATIONS"

Here's why National Truck- and Trailer-mounted Rigs will help you set new operating records . . .

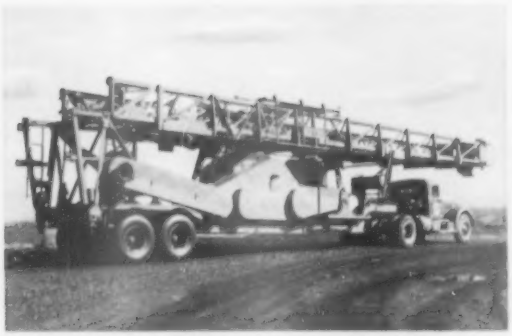
Rugged construction—These National truck- and trailer-mounted rigs are really built to take the punishment of year-around "mobile operations" in every kind of terrain. They have the same experienced design features, quality construction and service life that you expect to find in big National rigs.

On and off the job fast!—More and more operators are telling us how exceptionally fast these National rigs are on rig-ups and tear-downs. Compact, sectionalized design, adapted for your truck or trailer requirements, means that you move drawworks, pumps, engines and mast quickly—keep down-time between jobs at a minimum. These rigs can also be supplied as skid mounted units, if you prefer.

Built-in performance—Extra service life features are part of every National truck-and-trailer mounted rig. You'll find roller bearing mounted free-running drums, air controls, air-actuated clutches and fully enclosed cascade lubrication for all chains and sprockets. And because these rigs utilize torque converter drive, you can be sure of shock-proof operation and an infinite number of running speeds.

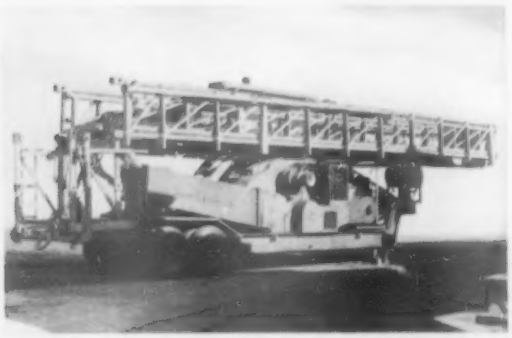
Get all the facts now—The National Supply representative or store in your area can give you complete descriptive bulletins on each of National's portable rigs. They can also supply operating information on such rigs in your own area. Why not let them be of service to you soon?

MOUNTED TO SUIT YOUR REQUIREMENTS



National T-20 in road position, equipped with 95 ft. mast

Trailer-mounted T-12 & substructure



Rotary drive side, National T-32 Rig with 96 ft. mast

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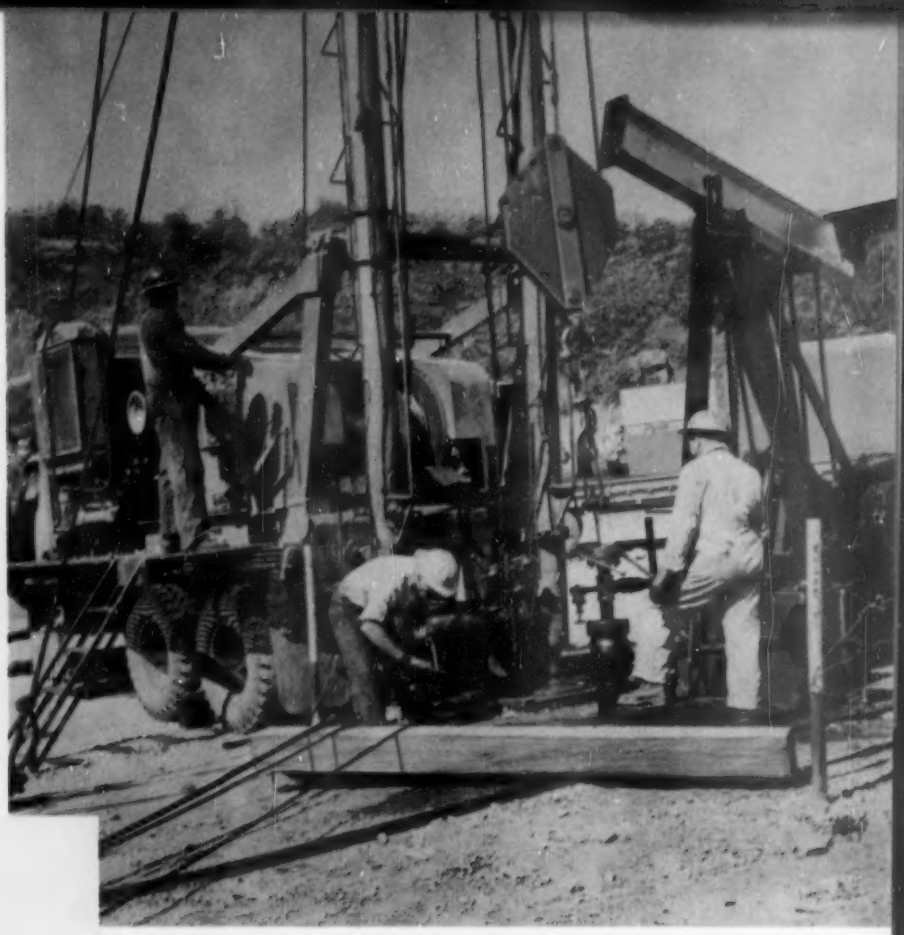
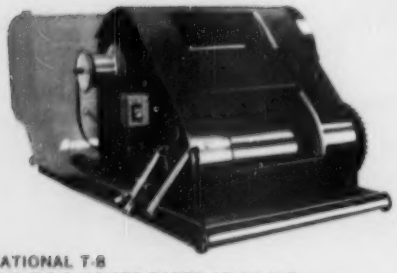
MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION OFFICES: Denver; Ft. Worth; Houston; Toledo; Tulsa; Torrance
CANADA: The National Supply Company, Ltd., 200 F. W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E. C. 1

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

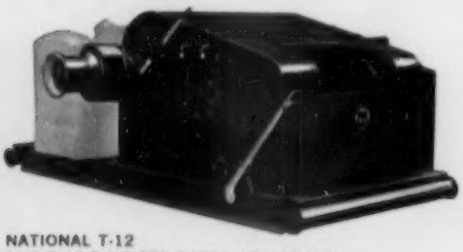
For information on National Hoists, see the next page

For new speed on your well-servicing jobs





NATIONAL T-8
AND T-8-S HOISTS RATED AT 80 H.P.
NORMAL SERVICING RANGE: 2000-4000 FT.



NATIONAL T-12
AND T-12-S HOISTS RATED AT 120 H.P.
NORMAL SERVICING RANGE: 3000-6000 FT.

NATIONAL HOISTS

Tailor-made for the versatile performance needed in well-pulling and well-servicing operations, National hoists are exceptionally compact and lightweight . . . especially suited for truck and trailer mounting.

Constructed as single units, drawworks and engine are mounted on a heavy steel H-beam skid frame. For maximum convenience in transportation or truck mounting, overall dimensions of National hoists conform to all highway width limits.

Operating features in these National hoists parallel the quality features found in all National rigs. Besides free-running drums, optional sand reels, air-operated controls and clutches, these National hoists utilize torque converter drive for smooth operation, a great variety of running speeds.

Get complete details on these highly versatile National hoists from the National Supply Representative or store in your area soon.

THE
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MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
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NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

New D-X refining executive . . .

. . . Up From a Pick and Shovel

D-X SUNRAY OIL CO. is about to launch an $8 to $10 million expansion program at its West Tulsa and Sunray Village refineries. And the man who will direct these expanded plants has probably worked on half the jobs that will be involved in the construction — from the most technical right down through the shops to the simplest labor detail.

He's Harry A. Brown, new vice president in charge of refining, the first man to hold such a title with the company.

Brown moved this month from Frontier Refining Co. in Cheyenne, Wyo., where he was vice president in charge of manufacturing and a member of the board of directors.

But his career in refining started at the other end of the line—about as far from the top as one can get and still be in the same business.

To more recent engineering graduates it might sound like fantasy, but he walked out of Oklahoma A. & M. College in 1933 with a brand new mechanical and petroleum engineering degree in his pocket—and spent the next 2 months looking for a job.

Pick and shovel start . . . When he found it, it was as a laborer with the maintenance gang at Anderson-Prichard Oil Corp.'s Cyril, Okla., refinery. His status was about the same as in his college days when he worked summers on coking and cleanout gangs to pay for his tuition.

But Brown felt lucky to get it. He was married and the father of two daughters and in those depression years good jobs were hard to come by, even with a degree to pave the way.

Six years later, Brown had worked on a good many jobs in every department at the Cyril refinery, becoming familiar with problems at all levels —up to and including the post of engineer.

Brown's next start was a little better. He went to Cosden Petroleum Corp. at Big Spring, Tex., as chief engineer. From there, he took successive steps up the ladder—to general superintendent of refining of the Grandville and Alma, Mich., refineries of Mid-West Refining Co., to Universal Oil Products Co. in Chicago and the Midwest, and then to Frontier Refining.

Brown joined U.O.P. in Chicago as an operating service engineer and ended up in Oklahoma as area engineer. During that period, he had his first personal contact with the company which was later to merge with Mid-Continent and set up the subsidiary which provided him with his present job.

Sunray Oil Corp., during an expansion program at its Allen, Okla., facilities, added one of the few three-coil cracking units ever installed. As U.O.P. engineer, Brown supervised the operational startup.

Brown left U.O.P. to take over as superintendent of refineries at Frontier, later moving up to the executive position of vice president in charge of manufacturing. The expansion record which unfolded under his direction there is enviable.

In 10 years, the basic crude capacity had increased from about 4,000 bbl. a day to about 16,000 bbl. He completed preliminary engineering plans and worked out economics for a further expansion which will boost throughput to more than 19,000 bbl. by the end of the year.

Brown, who grew up around refineries where his father worked during the depression years, is also an experienced hand at pipelining.

He was vice president of a Frontier subsidiary, Wyoming-Nebraska Pipe Line Co., which built the 6-in., 220-mile products line from Cheyenne to North Platte, Neb. Brown worked out the economics and set up procedures for construction of the line and later for tying it in with the Wyco line from Casper to Denver.

Busy executive . . . Brown isn't a desk man. He arrived in Tulsa July 2. Last week he had to ask a secretary how to get to his office in the Sunray building.

But he isn't mixed up. He's just busy —about the busiest person in the petroleum industry at present. He will coordinate operations of the two D-X Sunray refineries and he has been "out in the field" looking them over from every angle.

About future refining plans at D-X Sunray, Brown has little to say thus far. The way he puts it: "I want to get my feet on the ground and look around. Then we'll see."

But, while he's new on his present job, Brown is no stranger to this part of the country. His great grandparents were the first Presbyterian missionaries to the old Indian Territory and his grandfather was founder of the town of Wewoka, Okla.

The grandfather was also guardian of the Seminole Indian Nation and one of the few white men to be adopted into the tribe.

William B. Moore, chief geologist for Atlantic Refining Co. in Dallas, has been named manager of the company's newly formed South Louisiana-Gulf Coast region with headquarters at Lafayette, La. Succeeding Moore in Dallas will be **Robert N. Kolm,** now assistant chief geologist. **Bruce M. Choate,** exploration group manager for the Gulf Coast division, will transfer to the new division in the same capacity. **Barrett E. Booth,** general superintendent of drilling and production for the former Houston Oil Co., has been named operations group manager at Lafayette.

Raymond W. Todd, vice president of Pacific Lighting Gas Supply Co., has been elected president of the California Natural Gasoline Association. He was recipient of the 1954 C. N. G. A. award.

R. W. TODD

E. W. WALKER

E. W. Walker, Western Gulf Oil Co., was elected vice president and **E. R. Millett, Jr.,** was reappointed secretary-treasurer. Installation took place at the annual directors' meeting July 10.

Personals

Roy Marion, geologist in the Bismarck, N. D., office of Atlantic Refining Co., has been transferred to Durango, Colo.

John Magee, district geologist in the Bismarck, N. D., office of Socony Mobil Oil Co., has been transferred to Caracas, Venezuela.

C. L. Wilson, Service Pipe Line Co. district superintendent at Kearney, Neb., has been transferred to Mineral Wells, Tex., to replace **James J. Dougherty,** who has retired.

James H. Graham, Houston, director of unitization for Continental Oil Co., has retired.

Harold S. (Tommy) Thomas, regional research geologist for Phillips Petroleum Co., has retired. He will continue as an underground storage consultant for Phillips and others and will live in Bartlesville.

H. S. Gibson, managing director of Iraq Petroleum Co., Ltd., and associated companies, was appointed Knight Bachelor in birthday honors bestowed by Queen Elizabeth. Gibson is well known for his work on production of oil from limestone reservoirs and was president of the Institute of Petroleum from 1952 to 1954.

Clifford M. Larson, who retired July 1 as chief consulting engineer for Sinclair Refining Co., has entered private practice as a consulting engineer in New Rochelle, N. Y.

Olan Runnels has been appointed crude-oil representative for Shell Oil Co. in the Denver area. Runnels succeeds **J. K. Moore,** promoted to assistant manager of the crude-oil department in Houston.

H. S. M. Burns, president of Shell Oil Co., has received an honorary LL.D. degree from the University of Aberdeen, Scotland, where he studied geology and chemistry as an undergraduate after World War I. Burns went on from Aberdeen to take his master's in mathematics and physics at Clare College, Cambridge. He joined Shell Oil Co. in California after completing his work at Cambridge.

Halliburton Vice President Honored

Grover Kilgore, right, vice president of Halliburton Oil Well Cementing Co. in charge of sales and advertising, is shown receiving a gold watch in recognition of his 30 years of Halliburton service. The award was presented in Duncan, Okla., by Logan D. Campbell, vice chairman. Kilgore joined Halliburton in 1926 in Duncan as a cementing truck driver and later worked in various capacities in Oklahoma and Texas. He returned to Duncan in 1947 as sales manager and later was advanced to vice president. Kilgore studied geology at the University of Oklahoma, where he was an outstanding athlete.

Herbert Spencer, a founder and former president of Asphalt Institute, has been honored through establishment of a fellowship at Cornell University by Esso Standard Oil Co.

T. J. Oleszko, former operations superintendent, has been promoted to assistant manager of operations of Aurora Gasoline Co. **Harry Murphy** succeeds Oleszko as operations superintendent.

W. S. Ryan, formerly production engineer for Carter Oil Co. at Shreveport, has joined Tex-Penn Oil & Gas Corp. as petroleum engineer in the Corpus Christi office.

W. A. M. Greeven, a director of Creole Petroleum Corp., has been appointed deputy coordinator of the world-wide marketing activities of Standard Oil Co. (N. J.).

Allen Cordon, Washington lawyer formerly in the solicitor's office of the Interior Department, will succeed **Sidney L. Groom** as manager of the Bureau of Land Management's outer Continental Shelf office in New Orleans. Groom is leaving the department this week to enter private business.

R. W. Palmer, chief dispatcher in the pipeline department of General Petroleum Corp., Los Angeles, has been elected president of the newly formed Petroleum Pipe Line Chief Dispatchers organization. Other officers are **D. J. Cameron,** Shell Oil Co., vice president; and **G. L. Brown,** Richfield Oil Corp., secretary-treasurer.

J. M. Evans, formerly chief engineer of Standard Oil Co. of California, has been appointed assistant vice president to provide engineering counsel to Socal's operating companies. Succeeding him as head of the company's engineering department is **E. S. Warner,** who has been assistant chief engineer since 1947.

Dr. Bernard S. Friedman has been promoted to research associate of Sinclair Research Laboratories, Inc. Friedman joined Sinclair in 1948 as an assistant division director. He is the author of 20 scientific papers and has been awarded numerous patents in the fields of aviation gasoline, motor fuels, and petrochemical processes.

Donald Dean has been appointed assistant to the president of Anchor Petroleum Co., Tulsa.

Personals

Dr. Fred W. McLafferty has been appointed director of Dow Chemical Co.'s eastern research laboratory at Framingham, Mass.

R. MARMADUKE

Richard C. Marmaduke has been promoted by British-American Oil Producing Co. from division geologist at Oklahoma City to chief geologist at the company's headquarters office in Dallas. Marmaduke joined British-American as staff geologist in February 1952. **Harold J. Reedy** will replace Marmaduke as central division geologist at Oklahoma City.

N. C. Surber, geologist for Salt Dome Production Co., has resigned to join **Harold C. Hebert,** a geological-geophysical consultant.

Paul M. Wiley has been promoted to assistant district superintendent of The Texas Co.'s Panhandle district with headquarters at Pampa, Tex.

Hollis D. Hedberg, Gulf Oil Corp., Pittsburgh, and **Graham B. Moody,** consultant, Berkeley, Calif., have been nominated for the presidency of the American Association of Petroleum Geologists. Nominations for vice president are **B. Warren Beebe,** Keating Drilling Co., Oklahoma City, and **Grover E. Murray,** Louisiana State University, Baton Rouge. Other nominees are **William J. Hilseweck,** Blackwood & Nichols Co., Dallas, for secretary-treasurer, and **Sherman A. Wengerd,** University of New Mexico, Albuquerque, for editor.

Dr. Adalbert Farkas has joined the research and development division of Houdry Process Corp. as section chief in exploratory research. Farkas, who is program chairman for the first international catalysis congress which will be held in Philadelphia in September, was formerly with the Barrett division of Allied Chemical & Dye Corp.

Allen D. Schrodt, formerly with Southern Union Gas Co., Dallas, has been named director of the promotion, advertising, and research program of the American Gas Association. Schrodt succeeds **Otto E. Zwanzig.**

J. M. McIlvain, recently appointed European representative of the research and development department of Atlantic Refining Co., has established company offices in Germany.

Philip B. Herman has been named a vice president of American Petrochemical Corp.

Donald W. Weir has been named assistant to the president of Arkansas Louisiana Gas Co.

L. E. Battelle, chief civil engineer at General Petroleum Corp.'s Torrance refinery, has retired after 37 years of continuous service.

Dr. C. W. Smith, assistant head of Shell Development Co.'s plastic and resin department of Emeryville research center in California, has been given a 2-year assignment as technical assistant to **Dr. Harold Gershinowitz,** president of the company, in New York. Smith succeeds **Dr. F. M. McMillan,** who will return to Emeryville as head of the polymer and chemical applications department. **T. F. Mika** will serve as assistant department head in plastics and resins until Smith's assignment is completed.

Frank Hamlin has resigned from Cooperative Refinery Association to join Leben Drilling, Inc., as chief geologist.

C. Harrison Cooper has been named executive vice president and member of the executive committee of Ambassador Oil Corp., Fort Worth, succeeding **Luther Hudson**, who resigned.

W. E. Perkes has been appointed maanger of production for Tidewater Oil Co. in Saskatchewan.

C. S. Matthews, senior chemist in the physical department of Shell Development Co., Houston, has been named chief reservoir engineer. He will succeed **A. F. Everdingen,** who has been appointed manager of production economics in New York. **G. E. Archie** has been named assistant manager of the production technical services division in Houston.

C. H. Zachry, president of Southern Union Gas Co., has been nominated for president of the American Gas Association. Other nominees include **A. W. Conover,** president of Equitable Gas Co., for first vice president; **Robert W. Otto,** chairman of the board, Laclede Gas Co., for second vice president; and **Vincent T. Miles,** treasurer of Long Island Lighting Co., for treasurer. These nominees, selected by the general nominating committee of the A.G.A. will be voted upon by the membership at the 1956 annual convention in Atlantic City, Oct. 15-17.

E. E. Hurley has been named division chief engineer for Service Pipe Line Co.'s East Texas division, with headquarters at Fort Worth. Hurley joined Service in 1946 as an engineer. From 1950 to 1952 he was executive assistant to the vice president in charge of operations.

Dr. Parke A. Dickey, present head of geological research of Carter Oil Co. has been promoted to assistant chief of research responsible for both the geochemical and geological research sections. **Dr. John M. Hunt** has been named head of the newly formed geochemical research section. **Dr. Henry J. Schaetti** will become head of the geological research section.

George O. Suman has been promoted by Shell Oil Co. from mechanical engineer to drilling engineer in the area office in Los Angeles.

DEATHS

Dr. James J. Jang, 39, development engineer, and **Donald K. MacBain,** project engineer with Fluor Corp., Ltd., Los Angeles, were killed in the June 30 collision of two commercial airliners over the Grand Canyon.

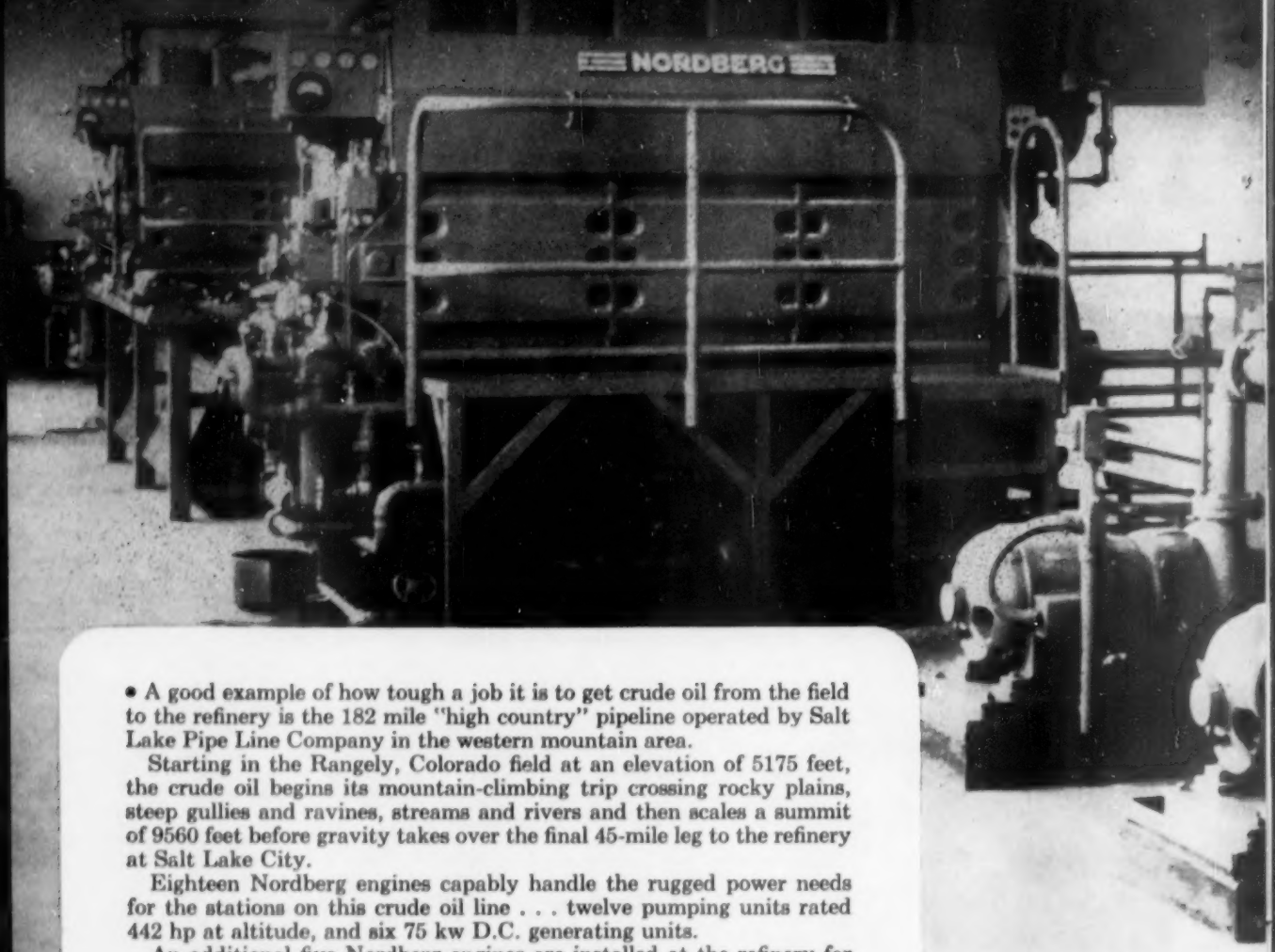
Philip Arnold, retired vice president of Garlock Packing Co., Palmyra, N. Y., died July 3 in Carmel, Calif.

Charles L. Supernaw, 56, district superintendent for Mid-Continent Pipe Line Co. at Hominy, Okla., died recently.

Dennard Marshall, chemist for Dowell Incorporated, died in Tulsa July 6.

Charley A. Wolfe died July 5 in Tulsa. He was formerly associated with Wolfe Brothers Oil Co. and Sinclair Oil & Gas Co.

23 NORDBERG ENGINES
power Crude and Products Pipe Lines of SALT LAKE PIPE LINE COMPANY



• A good example of how tough a job it is to get crude oil from the field to the refinery is the 182 mile "high country" pipeline operated by Salt Lake Pipe Line Company in the western mountain area.

Starting in the Rangely, Colorado field at an elevation of 5175 feet, the crude oil begins its mountain-climbing trip crossing rocky plains, steep gullies and ravines, streams and rivers and then scales a summit of 9560 feet before gravity takes over the final 45-mile leg to the refinery at Salt Lake City.

Eighteen Nordberg engines capably handle the rugged power needs for the stations on this crude oil line . . . twelve pumping units rated 442 hp at altitude, and six 75 kw D.C. generating units.

An additional five Nordberg engines are installed at the refinery for pumping refined products to market areas farther west . . . in all, a total of 23 Nordberg engines! While the majority of these engines operate on Rangely crude, the engines installed at the Rangely station are of the Duafuel® type to take advantage of the gas locally available.

This is but one example of the reliability of Nordberg power for pipeline operations. Write for further details.

NORDBERG MFG. CO., Milwaukee, Wisconsin

Two of three Nordberg 6-cylinder supercharged Diesels driving pumps on the No. 1 products line at the Salt Lake City Refinery.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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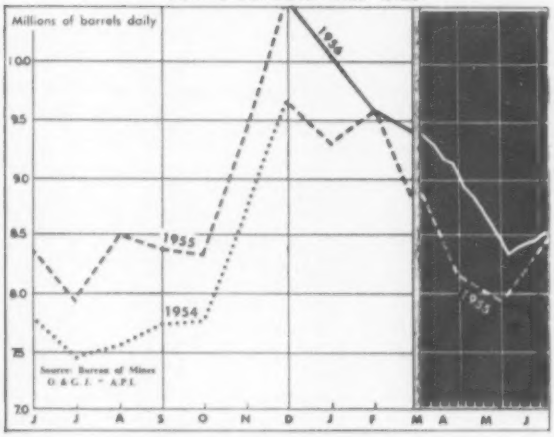
Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,088,950	UP	41,200	UP	465,103
Crude stocks	274,677,000	DOWN	954,000	UP	1,366,000
Completions	1,251	UP	133	UP	88
Refinery runs	7,974,000	DOWN	170,000	UP	328,000
Gasoline stocks	178,549,000	DOWN	2,897,000	UP	19,242,000
Kerosine stocks	26,760,000	UP	981,000	DOWN	3,696,000
Distillate stocks	98,289,000	UP	4,617,000	DOWN	6,878,000
Residual stocks	39,779,000	UP	1,405,000	DOWN	5,525,000
Four-product stocks	343,377,000	UP	4,106,000	UP	3,143,000
Total imports	1,425,800	UP	179,400	UP	185,200

TOTAL DEMAND—ALL OILS



Inland Storage Will Hold Residual If Steel Mills Fire Up By July 31

THE most sensitive residual markets are in the Group 3 area. There has been no rush in the Mid-Continent to force heavy fuel on the market in recent weeks, and there have been no quotations at dump prices. The general opinion in the area is that the surplus residual, due to the steel strike, can be handled if movement to the steel mills is resumed by the end of July.

The effect of the current steel strike on residual-fuel markets cannot be gaged accurately by comparison with changes that resulted from the strike in 1952. In the first place, the steel strike in 1952 came at the end of a refinery strike of more than 3 weeks that had reduced over-all product inventories.

Also, the drop in residual prices during the summer of 1952 can be charged more to the general downward trend of the residual market that year than to the effects of the steel strike.

The Group 3 low quotation for high-sulfur residual at the start of the year 1952 was $1.65 a barrel. For the remainder of the year the low of quotations dropped about as follows: $1.55 on January 30, $1.45 on March 5, $1.35 on April 2, $1.30 on April 30, and $1.25 on June 4. The larger reduction to $1.00 on June 25 may have been related to the steel strike, but further cuts that brought the price down to $0.85 by October 8 seems to be in line with the downward trend of the first half of the year.

Another factor in the picture is the abnormal pattern of stock changes by areas. The table at the bottom of the page shows residual stocks for the West Coast and for all other areas to the east.

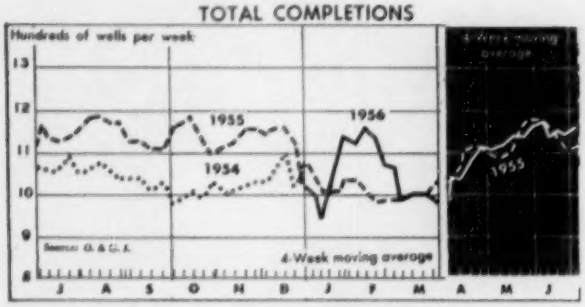
Most of the effect of the steel strike will be felt in areas east of California. Residual inventories for these areas were below previous year's levels through July 1955 but have been in excess of previous year's stocks since that time. Stocks at the end of June were about 1,200,000 bbl. above 1955 and about 700,00 bbl. above 1954.

RESIDUAL STOCKS—END OF MONTH
(Thousands of barrels)

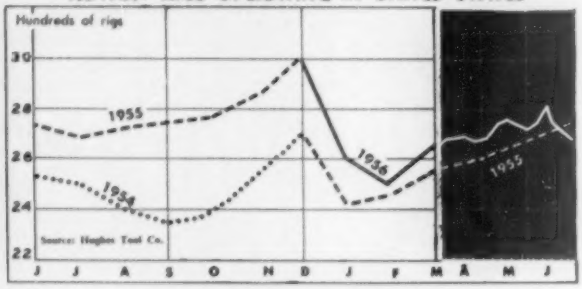
	Stocks		Change from previous year	
	West Coast	Rest of U. S.	West Coast	Rest of U. S.
1954:				
December	29,429	22,676	8,380	— 5,651
1955:				
January	27,013	22,444	5,457	— 2,054
February	24,969	21,073	3,034	— 4,111
March	24,838	20,132	3,978	— 3,257
April	23,884	19,954	2,404	— 2,928
May	22,683	22,400	— 609	— 1,317
June	20,127	24,271	— 5,404	— 414
July	17,767	27,127	— 8,995	— 476
August	15,901	29,579	—12,250	1,519
September	14,974	31,930	—13,924	4,126
October	14,860	32,180	—14,510	5,150
November	13,754	30,317	—16,255	5,435
December	11,810	27,364	—17,619	4,688
1956:				
January	11,446	26,801	—15,567	4,357
February	10,664	25,009	—14,050	3,936
March	10,716	22,268	—14,122	2,136
April	10,498	22,242	—13,386	2,288
May*	11,950	23,886	—10,733	2,164
June*	12,896	25,478	— 7,231	1,207

*From weekly data nearest end of month.

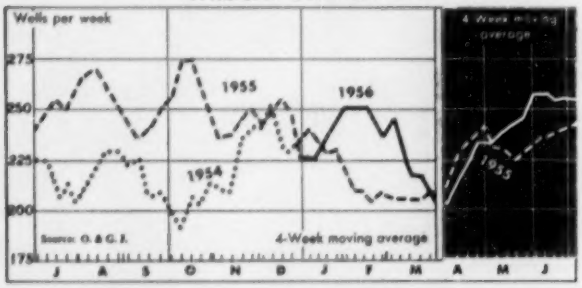
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	7-9-56	7-2-56	7-11-55
North Central and East	145	140	151
Southeast	29	29	25
Okla., Kans., Ark., Mo.	464	483	506
Louisiana	452	445	415
North and East Texas-Panhandle	407	413	385
Gulf and South Texas	251	259	235
West Texas-New Mexico	518	536	524
Rocky Mountain	275	277	294
Pacific Coast	131	126	146
Total United States	2,672	2,708	2,681
Western Canada	236	235	209

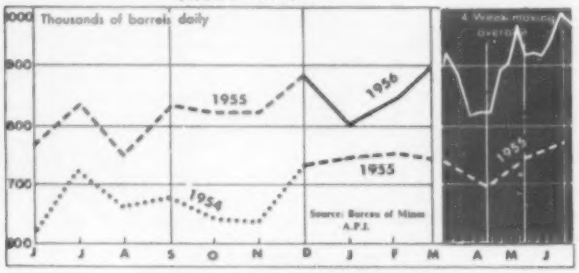
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS... WEEK ENDED JULY 7, 1956

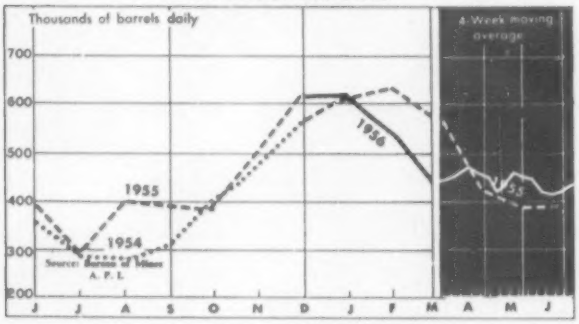
	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1956				
	Comp.	Oil	Gas	Dry	Footage	1956	1955	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	6	2	0	4	49,987	58	44	0	0	0	3	3	0	0	1	27	28
Arkansas	17	12	0	5	49,424	403	370	1	0	0	1	2	20	0	3	66	89
California	37	27	1	9	167,178	1,123	1,326	1	0	0	6	7	22	0	3	215	240
Colorado	26	4	3	19	121,195	611	716	1	0	1	15	17	17	0	7	271	295
Illinois	80	38	1	41	185,081	1,885	1,909	0	0	1	14	15	27	0	1	326	354
Indiana	21	11	0	10	34,592	326	393	1	0	0	2	3	10	0	1	59	70
Kansas	99	41	5	*53	320,243	2,636	2,643	7	0	2	15	24	71	2	15	474	562
Kentucky	38	15	4	19	59,520	876	659	0	0	0	8	8	25	0	1	183	209
Louisiana	78	39	12	27	573,732	2,013	2,084	0	0	3	10	13	58	31	33	260	382
North	35	18	3	14	119,160	826	1,101	0	0	0	5	5	16	1	1	100	118
South	33	16	7	10	371,091	955	983	0	0	1	4	5	33	27	22	143	225
Offshore	10	5	2	3	83,481	232	...	0	0	2	1	3	9	3	10	17	39
Michigan	6	4	0	2	14,405	235	265	0	0	0	2	2	5	0	0	75	80
Mississippi	12	3	0	9	83,073	230	250	0	0	0	5	5	9	1	1	90	101
Montana	7	4	0	3	45,786	182	162	1	0	0	2	3	9	0	0	49	58
Nebraska	24	10	0	14	136,215	548	378	1	0	0	10	11	23	0	0	245	268
New Mexico	46	18	18	10	184,885	961	803	3	0	0	4	7	29	0	6	85	120
Northwest	22	0	17	5	72,198	372	234	0	0	0	2	2	2	0	5	26	33
Southeast	24	18	1	5	112,687	589	569	3	0	0	2	5	27	0	1	59	87
North Dakota	5	1	0	4	32,100	124	119	0	0	0	4	4	7	0	0	28	35
Ohio	24	12	7	*5	58,571	534	583	0	0	0	0	0	0	0	1	4	5
Oklahoma	156	93	11	†52	599,405	4,475	4,544	1	0	1	12	14	66	15	26	374	481
Pennsylvania-New York	99	40	3	‡56	80,598	613	851	0	0	0	5	5	0	0	4	8	12
Texas	434	266	22	146	1,853,093	11,394	10,380	11	1	3	93	108	393	19	100	2,443	2,955
Southwest (1 & 4)	49	23	5	21	204,689	1,669	1,622	0	0	0	11	11	73	5	36	445	559
Gulf Coast (2 & 3)	49	18	7	24	329,967	1,388	1,324	1	1	1	15	18	37	10	36	367	450
East (5 & 6)	19	7	4	8	103,284	583	500	1	0	0	6	7	9	1	5	210	225
N. Central (7-B & 9)	149	72	0	77	477,415	4,109	3,829	6	0	0	48	54	171	0	3	984	1,158
West (7-C & 8)	135	120	0	15	607,912	2,985	2,598	3	0	0	12	15	94	0	9	405	508
Panhandle (10)	33	26	6	1	129,826	660	507	0	0	2	1	3	9	3	11	32	55
Utah	3	1	1	1	18,503	67	37	0	0	0	0	0	1	0	2	37	40
West Virginia	8	0	5	3	17,589	336	319	0	0	0	1	1	0	0	6	7	13
Wyoming	23	9	4	10	86,073	399	399	0	0	0	4	4	8	0	6	97	111
Miscellaneous (Tenn.)	2	0	0	2	4,682	60	17	0	0	0	2	2	4	0	0	48	52
Total U. S.	1,251	650	97	504	4,775,930	30,089	29,251	28	1	11	218	258	804	68	217	5,471	6,560
Total previous week	1,118	557	98	463	4,307,899	...	...	31	1	13	218	263	776	67	206	5,253	6,302
Total July 9, 1955	1,163	653	72	438	4,645,225	...	...	44	0	5	197	246	825	107	185	4,994	6,111
Cumulative 1956	30,089	16,525	2,008	11,556	122,102,965	...	...	...	...	...	...	...	...	...	...	...	...
Western Canada	87	69	5	13	388,421	1,377	...	...	...	...	...	...	...	...	...	...	...

Service wells included: *2, †4, ‡42.

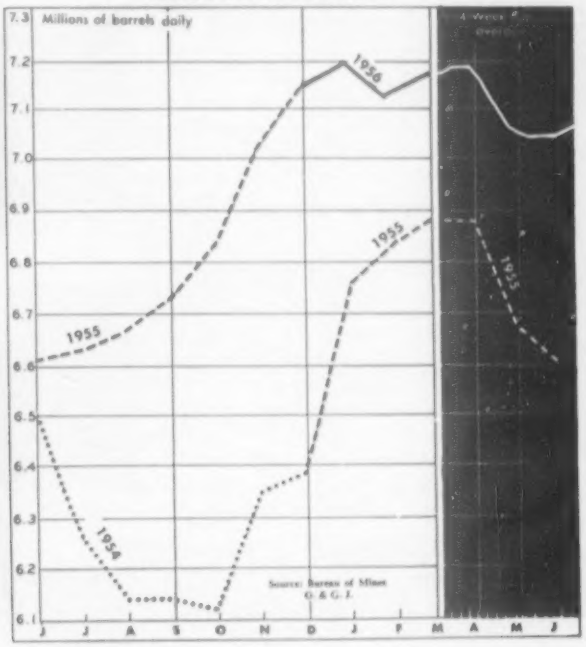
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

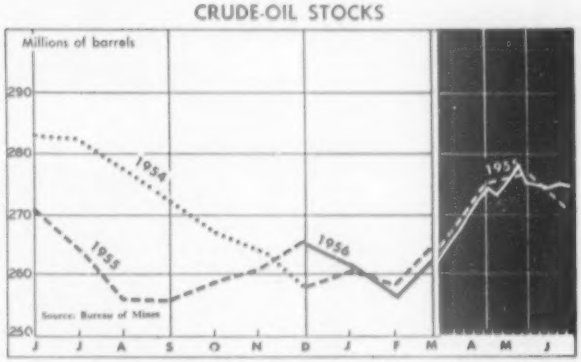


DAILY AVERAGE PRODUCTION FOR WEEK

	July 7, 1956			June 30
	Crude oil	Lease condensate	Total	total
Alabama	6,500		6,500	6,600
Arkansas	74,850	450	75,300	75,400
California	967,400		967,400	964,500
Colorado	162,300		162,300	165,500
Eastern	49,500		49,500	50,300
Florida	1,325		1,325	1,350
Illinois	231,100		231,100	227,800
Indiana	31,700		31,700	31,800
Kansas	342,500		342,500	343,200
Kentucky	47,500		47,500	47,400
Louisiana	727,650	57,300	784,950	785,600
North	119,650	2,300	121,950	123,600
South	608,000	55,000	663,000	662,000
Michigan	29,400		29,400	29,400
Mississippi	107,300	4,350	111,650	111,050
Montana	61,400		61,400	61,900
Nebraska	38,500		38,500	37,200
New Mexico	232,500	4,325	236,825	240,800
North Dakota	31,700		31,700	32,400
Oklahoma	581,600		581,600	584,400
Texas	2,953,500	48,300	3,001,800	2,956,450
Dist. 1	56,000	425	56,425	54,425
Dist. 2	147,000	8,000	155,000	153,025
Dist. 3	434,000	22,500	456,500	450,625
Dist. 4	234,000	5,500	239,500	236,350
Dist. 5	44,000	375	44,375	44,425
Dist. 6	123,000	5,500	128,500	125,500
East Texas field	210,500		210,500	204,000
Dist. 7-B	156,000	50	156,050	153,050
Dist. 7-C	182,000	3,800	185,800	187,800
Dist. 8	1,055,000	1,600	1,056,600	1,035,700
Dist 9	215,000	400	215,400	216,400
Dist. 10	97,000	150	97,150	95,150
Utah	4,600		4,600	5,000
Wyoming	291,100		291,100	289,400
Others	‡300		‡300	300
Total U. S.	6,974,225	114,725	**7,088,950**	7,047,750
Change from previous wk., up			**41,200**	
Canada	†408,900		†408,900	†463,800
Total U. S. production January 1-July 7			§1,353,470,720 bbl.	
Same period last year (crude plus cond.)			*1,272,659,735 bbl.	

*Includes 21,169,250 bbl. condensate. †Week ended previous Monday. ‡Nev. 200, S. D. 100. §Revised.

CRUDE-OIL STOCKS



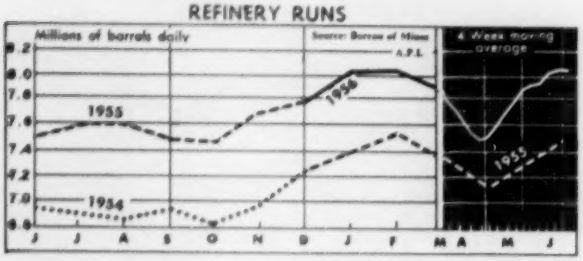
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

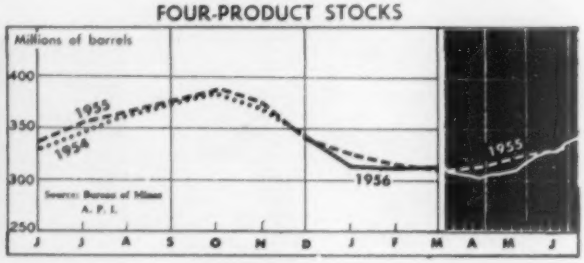
	6-30-56	6-23-56	7-2-55
Pennsylvania Grade	2,665	2,607	2,825
Other Appalachian	2,395	2,286	1,847
Illinois, Indiana, Michigan	11,686	11,301	11,751
Nebraska, North Dakota	2,340	2,681	1,866
Kansas	8,938	9,056	7,781
Oklahoma	25,922	26,754	23,112
Arkansas	2,937	3,031	2,775
Louisiana	15,440	15,518	15,998
North	2,490	2,537	2,902
South	12,950	12,981	13,096
Mississippi	2,878	3,094	3,002
New Mexico	7,284	7,432	8,538
Texas	123,056	123,958	128,902
East Texas proper	9,311	9,178	9,772
West Texas	60,093	60,447	57,602
Texas Gulf	21,518	22,402	25,728
Other Texas	32,134	31,931	35,800
Wyoming	19,013	18,735	15,788
Other Rocky Mountain	7,187	6,338	5,680
California	28,523	27,918	31,876
Foreign	†14,413	14,922	11,570
Total	274,677	275,631	273,311

*Bureau of Mines. †Includes 3,540,000 bbl. in California.

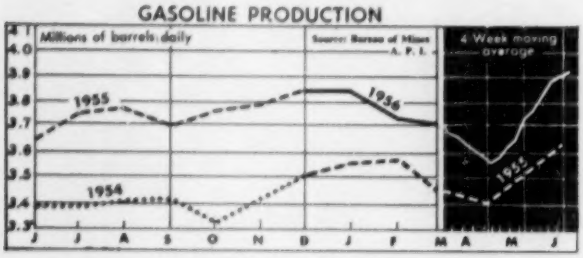
REFINERY RUNS



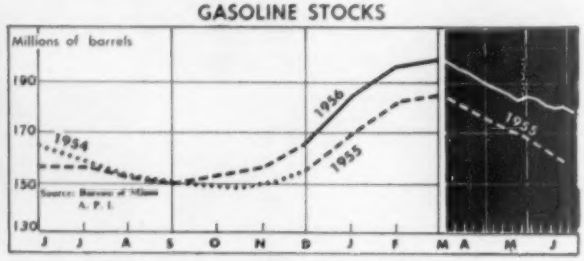
FOUR-PRODUCT STOCKS



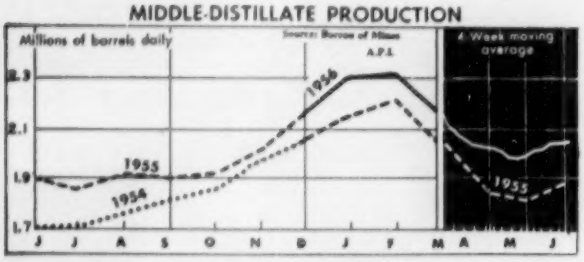
GASOLINE PRODUCTION



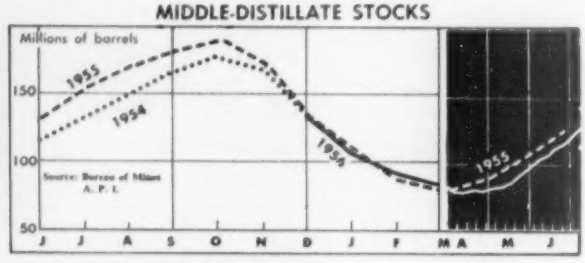
GASOLINE STOCKS



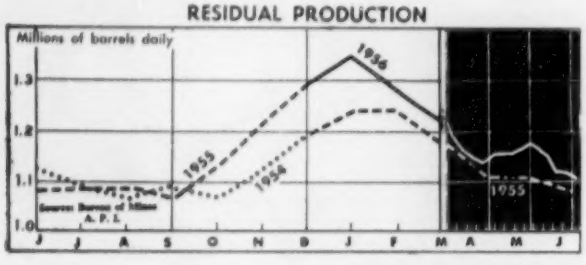
MIDDLE-DISTILLATE PRODUCTION



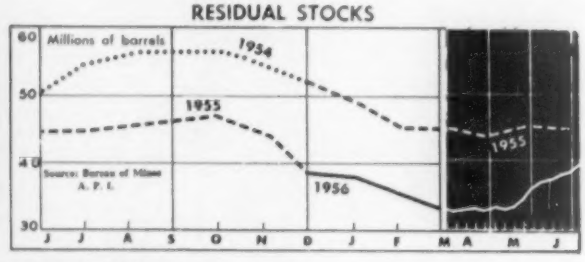
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, JULY 6

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, July 1955 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,146	485.4	26.3	317.4	209.0	40,155	10,402	29,716	9,965	1,101	450.2	24.0	267.6	195.7
Appalachian:														
District 1	106	37.6	4.1	21.4	5.6	4,327	502	1,893	325	101	40.9	4.1	24.6	4.0
District 2	102	52.4	1.7	17.0	10.0	2,880	624	801	281	100	55.5	2.1	11.7	13.6
Ind., Ill., Ky.	1,353	728.4	69.7	265.1	154.2	32,502	4,988	14,182	4,494	1,436	788.1	70.5	268.4	162.1
Minn., Wis., Dak.	91	45.4	9.6	19.9	7.4	6,480	849	4,988	279	(§)	(§)	(§)	(§)	(§)
Okla., Kans., Mo.	726	411.9	14.6	166.3	28.1	15,633	1,438	9,960	1,264	675	401.7	17.7	153.7	31.1
Inland Texas	277	196.4	11.3	47.0	24.0	6,708	415	1,782	1,422	252	173.4	6.7	47.8	22.6
Texas Gulf Coast	1,926	926.3	101.4	500.9	238.0	24,856	3,887	13,831	5,805	1,812	868.6	93.0	411.3	251.8
La. Gulf Coast	749	382.3	40.3	192.9	53.1	10,242	2,381	6,207	1,804	615	309.4	52.3	144.1	35.4
N. La. and Ark.	99	39.2	6.1	25.9	6.1	4,195	504	1,779	165	93	33.9	7.1	23.0	5.5
Rocky Mountain:														
New Mexico	23	11.7	.....	4.0	2.9	420	3	96	13	23	11.7	0.2	4.0	3.4
Other Rocky Mtn.	279	139.9	4.6	56.1	35.0	6,843	368	2,682	895	275	125.1	5.4	58.7	34.1
California	1,097	505.4	.....	142.4	323.3	23,308	399	10,372	13,067	1,097	485.3	3.2	160.3	331.8
July 6, 1956	7,974	3,962.3	289.7	1,776.3	1,096.7	178,549	26,760	98,289	39,779	7,580	3,743.8	286.3	1,575.2	1,091.1
June 29, 1956	8,144	3,926.0	303.6	1,765.4	1,137.4¶	181,446	25,779	93,672	38,374	.....	.....	.....	.....	.....
July 8, 1955	7,646	3,782.6	269.6	1,639.1	1,083.3	159,307	30,456	105,167	45,304	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines. §Included in Indiana, Illinois, Kentucky. ¶Revised.

Crude-oil and refinery prices at representative U. S. and foreign points

REFINED-PRODUCT PRICES

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (88 octane)	11.50-12.00
Premium (96 octane)	13.25-13.75
Gulf Coast (cargoes for coastwise or export movement):	
Regular (90 octane)	11.25-11.50
Regular (92 octane)	11.50-12.00
Premium (97 octane)	13.00-13.25
Premium (98 octane)	13.25-13.75
California—Los Angeles (rack):	
Regular (84 octane)	12.9-13.3
Premium (93 octane)	14.9-15.3
Caribbean area (cargoes):	
Regular (87 octane)	10.50
Premium (93 octane)	11.75

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

NATURAL GASOLINE*

Group 3:	
Grade 26-70	4.5
Breckenridge:	
Grade 26-70	4.0

*If 26-70 natural is considered as 100 per cent, prices for lower-vapor-pressure grades increase 2.5 per cent for each unit drop in Reid vapor pressure down to and including 16-lb. Prices for grades below 16-lb. may vary slightly by areas or plants.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	10.00-10.25
Diesel oil (58 d.i. and above)	9.625-9.875
Distillate No. 1	9.625-9.875
Distillate No. 2	8.75-9.00
Gulf Coast (cargoes):	
Kerosine 41-43	9.5
Distillate No. 2	8.75-9.25
New York Harbor (barges):	
Kerosine 41-43	10.85
Distillate No. 2	10.35
Diesel fuel, 48-52 d.i.	10.65
Caribbean area (cargoes):	
Distillate No. 2	8.75

WAX (LB.)

Oklahoma (Group 3):	
132-135 A.m.p. (semi-refined) in tank cars	6.50
New York (export):	
126-130 A.m.p. crude scale (solid in bags or barrels)	7.35

★Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
Residual fuel (max. 1% S)	$2.00-2.10
Gulf Coast (cargoes):	
Bunker C fuel	$2.10
New York Harbor (barges):	
Bunker C fuel	$2.80
Caribbean (cargoes):	
Bunker C at Aruba, N.W.I.	$2.10
California (rack):	
Bunker C fuel, Los Angeles	$2.15-2.25

LUBRICATING OILS

Mid-Continent (Group 3):	
150-160 bright stock, solvent refined, 0-10 p.p., 95 v.i.	24
200 vis. neutral oil, solvent refined, 0-10 p.p., 95 v.i.	20.75
Pennsylvania Grade:	
145-155 vis. at 210, bright stock, 8 color, 25 p.t.	26
200 vis. neutral (180 at 100°), 25 p.t.	23

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Mid-Cont.*	Gulf Coast Tex.†	West Tex.‡ N.M.	Wyo. (sour)
14-14.9	$2.02				
15-15.9	2.08				
16-16.9	2.13				
17-17.9	2.19				
18-18.9	2.24				
19-19.9	2.30				
20-20.9	2.35	$2.50		$2.37	
21-21.9	2.41	2.52		2.39	
22-22.9	2.47	2.54		2.41	
23-23.9	2.52	2.56		2.43	
24-24.9	2.58	2.58	$2.91	2.45	
25-25.9	2.64	2.60	2.93	2.47	$2.13
26-26.9	2.69	2.62	2.95	2.49	2.19
27-27.9	2.76	2.64	2.97	2.51	2.24
28-28.9	2.83	2.66	2.99	2.53	2.29
29-29.9	2.91	2.68	3.01	2.55	2.34
30-30.9	2.97	2.70	3.03	2.57	2.39
31-31.9	3.04	2.72	3.05	2.59	2.44
32-32.9	3.12	2.74	3.07	2.61	2.48
33-33.9	3.20	2.76	3.09	2.63	2.52
34-34.9	3.27	2.78	3.11	2.65	2.56
35-35.9	3.34	2.80	3.13	2.67	2.60
36-36.9	3.39	2.82	3.15	2.69	2.64
37-37.9		2.84	3.17	2.71	2.66
38-38.9		2.86	3.19	2.73	2.68
39-39.9		2.88	3.21	2.75	2.70
40 and up		2.90	3.23	2.77	2.72

*Includes Oklahoma, Kansas, North Dakota, West Texas (sweet), North Central Texas, North Louisiana, Arkansas. †Low-cold-test Gulf Coast. ‡Sour.

Effective dates: California, February 7, 1956; east of California, June 15, 1953; Pennsylvania Grade, May 16, 1956.

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Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	4.45
Middle District	4.32
Southwest Pennsylvania	4.03
West Virginia	3.91
Buckeye Grade	3.85
Zanesville Grade	3.10
Illinois Basin	2.90
Canada:	
Leduc-Woodbend (flat prices D-2, D-3)	2.60
Redwater (Alta.) D-3	2.49
Smiley-Viking (Sask.)	2.26
Fosterton (Sask.)	1.29
Pembina	2.52

FOREIGN

Venezuela:	
Cumarebo, 48°-49.8°, Tucupido	*3.40
San Joaquin, 41°-41.9°, Puerto La Cruz	*3.04
Oficina, 35°-35.9°, Puerto La Cruz	*2.80
★ Tia Juana medium, 26.5°-26.9°, Amuay§	†2.30
Quiriquire, 16.5°-16.9°, Caripito	‡2.21
Lagunillas heavy, flat, Amuay or Las Piedras§	2.05
Bachaquero, 16.5°-16.9°, Amuay or Las Piedras§	‡1.90

*Plus or minus 2 cents per barrel for each degree gravity change. †Plus or minus 2.5 cents per barrel for each half-degree gravity change. ‡Plus or minus 3.5 cents per barrel for each half-degree gravity change. §Also available at La Salina at 3.0 cents per barrel less.

Middle East, Persian Gulf (cargoes, f.o.b. lifting port):	
Arabian, 36.0°-36.9°, Ras Tanura	$1.97
Iranian, 34.0°-34.9°, Bandar Mashur	1.91
Iranian, 34.0°-34.9°, Abadan	1.86
Iraq, 36.0°-36.9°, Fao	1.87
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.72
Qatar, 39.0°-39.9°, Umm Said	2.06
Middle East, E. Mediterranean:	
Arabian, 36.0°-36.9°, Sidon	2.46
Iraq, 36.0°-36.9°, Tripoli, Banias	2.46
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°-38°	2.60

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Box J-528, The Oil and Gas Journal, Tulsa, Oklahoma.

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BOX J-618,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

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SITUATIONS WANTED

GEOLOGIST, 32, 7 years varied experience, presently in supervisory capacity, desires employment with aggressive independent. Box J-623, The Oil and Gas Journal, Tulsa, Oklahoma.

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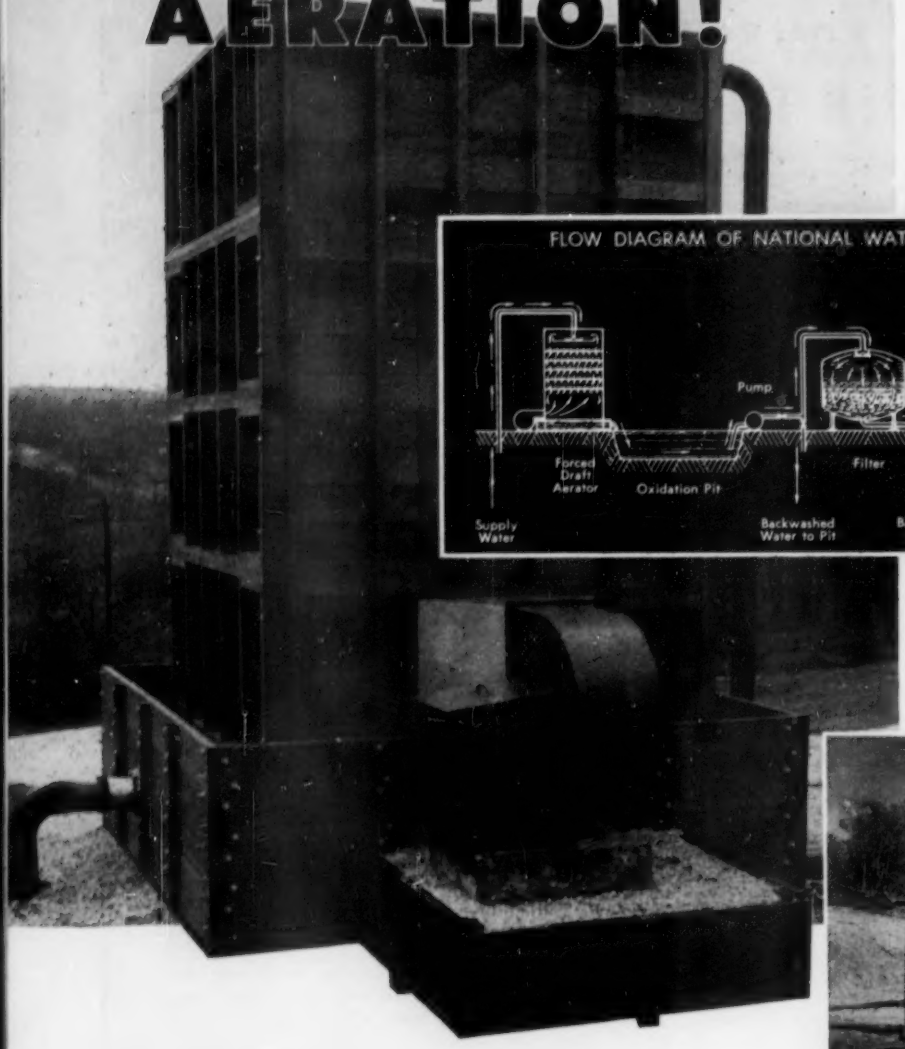

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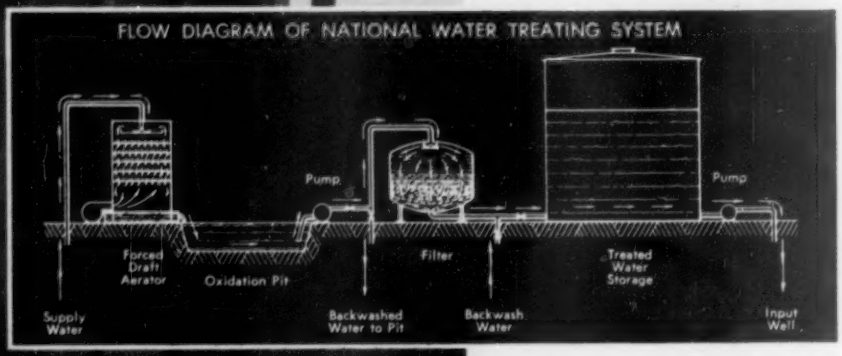

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